# Pre-lab
# Lab 6: Energy/Momentum Conservation

**Name : _____**

**NetID : _____** **Grade:_____/30**

**Signature: _____**

- You are encouraged to have discussions with TA and other students, but you are required to do calculations and answer questions individually and independently.

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**Question: [30]**

(1)

i. Fill in the predicted velocity with sign and % difference between the predicted and measured values. [8]

| Collision type | predicted $v_{1,f}$ | % diff in $v_{1,f}$ | predicted $v_{2,f}$ | % diff in $v_{2,f}$ |
|---|---|---|---|---|
| Elastic | | | | |
| Completely inelastic | | | | |

ii. Fill in the initial value, final value, and % loss. [6]

| Collision type | Momentum ($\mathrm{kg \times m/s}$) | | | Kinetic Energy ($\mathrm{kg \times m^2/s^2}$) | | |
|---|---|---|---|---|---|---|
| | Initial $p_{1,i} + p_{2,i}$ | Final $p_{1,f} + p_{2,f}$ | % loss | Initial $K_{1,i} + K_{2,i}$ | Final $K_{1,f} + K_{2,f}$ | % loss |
| Elastic | | | | | | |
| Completely inelastic | | | | | | |

(2) Explain the four statements about the elastic collision experiment. [8]

**Answer:**

(3) Show $\frac{|K_{f,1}+K_{f,2}-K_{i,1}-K_{i,2}|}{|K_{i,1}+K_{i,2}|} = \frac{m_2}{m_1+m_2}$ for a completely inelastic collision and explain how this relation tells that the energy is not conserved. [4]

**Answer:**

(4) Show that $v_{1,f} = v_{1,i}$ and $v_{2,f} = v_{2,i}$ satisfy the conservation equations and explain why it is not a solution to an elastic collision problem. [4]

**Answer:**

# Report Sheets
# Lab 6: Energy/Momentum Conservation

**Name : _____** **Report Grade:_____/70**

**NetID : _____** **Total Grade:_____/100**

**Signature: _____**

- You are encouraged to have discussions with TA and other students, but you are required to do calculations and answer questions individually and independently.

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***Part I: Elastic collision***

Glider 1 : Bare mass = _____ ± _____ g.

Glider 2 : Bare mass = _____ ± _____ g.

*For only one measurement, the error part is the measurement error.

**Table R1:**

| Mass configuration | Trial | $v_{1,i}$(m/s) | $v_{1,f}$(m/s) | $v_{2,f}$(m/s) |
|---|---|---|---|---|
| $m_1 = m_2$: 40 g on Glider 1, 40 g on Glider 2 | 1 | | | |
| | 2 | | | |
| $m_1 < m_2$: 40 g on Glider 1, 200 g on Glider 2 | 3 | | | |
| | 4 | | | |
| $m_1 > m_2$: 200 g on Glider 1, 40 g on Glider 2 | 5 | | | |
| | 6 | | | |

***Part II: Completely inelastic collision***

**Table R2:**

| Mass configuration | Trial | $v_{1,i}$(m/s) | $v_f (= v_{1(2),f})$ (m/s) |
|---|---|---|---|
| $m_1 = m_2$: 40 g on Glider 1, 40 g on Glider 2 | 1 | | |
| | 2 | | |
| $m_1 < m_2$: 40 g on Glider 1, 200 g on Glider 2 | 3 | | |
| | 4 | | |
| $m_1 > m_2$: 200 g on Glider 1, 40 g on Glider 2 | 5 | | |
| | 6 | | |

**Check Box #1 [30]:** The data sets are checked**.**

**Analysis I [20]: Elastic collision**

(1) Use Eqs. (7) and (8) in **Manual** to predict $v_{1,f}$ and $v_{2,f}$ from the measured $v_{1,i}$ in **Table R1** and compare them with the measured values. Complete **Table R3** below. [6] (Note that $m_{1,2}$ are bare mass plus added mass, and % difference $= \frac{|\text{measured value} - \text{predicted value}|}{|\text{predicted value}|} \times 100\%$)

**Table R3:**

| Mass config. | Trial | $v_{1,f}$(m/s) | | | $v_{2,f}$(m/s) | | |
|---|---|---|---|---|---|---|---|
| | | Predicted | Measured | % diff | Predicted | Measured | % diff |
| $m_1 = m_2$ $m_1$:_____ kg $m_2$:_____ kg | 1 | | | | | | |
| | 2 | | | | | | |
| $m_1 < m_2$ $m_1$:_____ kg $m_2$:_____ kg | 3 | | | | | | |
| | 4 | | | | | | |
| $m_1 > m_2$ $m_1$:_____ kg $m_2$:_____ kg | 5 | | | | | | |
| | 6 | | | | | | |

(2) For each mass configuration in **Table R3**, select one trial that has a smaller % difference and analyze its momentum and energy loss upon the collision (use the measured velocities in **Table R1**). Complete **Table R4** below in SI units. [6] (% loss $= \frac{|\text{final value} - \text{initial value}|}{|\text{initial value}|} \times 100\%$)

**Table R4:**

| Mass Config. | Trial # | Momentum (kg·m/s) | | | Kinetic Energy (J) | | |
|---|---|---|---|---|---|---|---|
| | | $p_{1,i} + p_{2,i}$ | $p_{1,f} + p_{2,f}$ | % loss | $K_{1,i} + K_{2,i}$ | $K_{1,f} + K_{2,f}$ | % loss |
| $m_1 = m_2$ | | | | | | | |
| $m_1 < m_2$ | | | | | | | |
| $m_1 > m_2$ | | | | | | | |

(3) Assuming that the air friction is responsible for up to 15% momentum or energy loss, discuss how your results have (roughly) confirmed or contradicted the conservation law for elastic collisions if there is no air friction. Do different mass configurations show the same physics of conservation (or non-conservation)? Why or why not? [4]

**Answer:**

(4) Which trial in **Table R4** has the largest % loss in total momentum? Please discuss possible reasons for this *relatively large* loss rate. [4]

**Answer:**

**Analysis II [18]: Completely inelastic collision**

(1) Use Eq. (9) in **Manual** to predict $v_f$ from the measured $v_{1,i}$ in **Table R2** and compare them with the measured values. Complete **Table R5** below. [6]

**Table R5:**

| Mass config. | Trial | $v_f$(m/s) | | |
|---|---|---|---|---|
| | | Predicted | Measured | % difference |
| $m_1 = m_2$<br>$m_1$:_____ kg<br>$m_2$:_____ kg | 1 | | | |
| | 2 | | | |
| $m_1 < m_2$<br>$m_1$:_____ kg<br>$m_2$:_____ kg | 3 | | | |
| | 4 | | | |
| $m_1 > m_2$<br>$m_1$:_____ kg<br>$m_2$:_____ kg | 5 | | | |
| | 6 | | | |

(2) For each mass configuration in **Table R5**, select one trial that has a smaller % difference, and analyze its momentum and energy loss upon the collision (use the measured velocities in **Table R2**). Complete **Table R6** below in SI units. [6]

**Table R6:**

| Mass Config. | Trial # | Momentum (kg·m/s) | | | Kinetic Energy (J) | | |
|---|---|---|---|---|---|---|---|
| | | $p_{1,i} + p_{2,i}$ | $p_{1,f} + p_{2,f}$ | % loss | $K_{1,i} + K_{2,i}$ | $K_{1,f} + K_{2,f}$ | % loss |
| $m_1 = m_2$ | | | | | | | |
| $m_1 < m_2$ | | | | | | | |
| $m_1 > m_2$ | | | | | | | |

(3) Assuming that the air friction is responsible for up to 15% momentum or energy loss, discuss how your results have (roughly) confirmed or contradicted the conservation law for completely inelastic collisions if there is no air friction. Do different mass configurations show the same physics of conservation (or non-conservation)? Why or why not? [4]

**Answer:**

(4) Which configuration in **Table R6** has the largest % loss in energy? How do you use the relation in Pre-lab Q(3) to explain it? [4]

**Answer:**