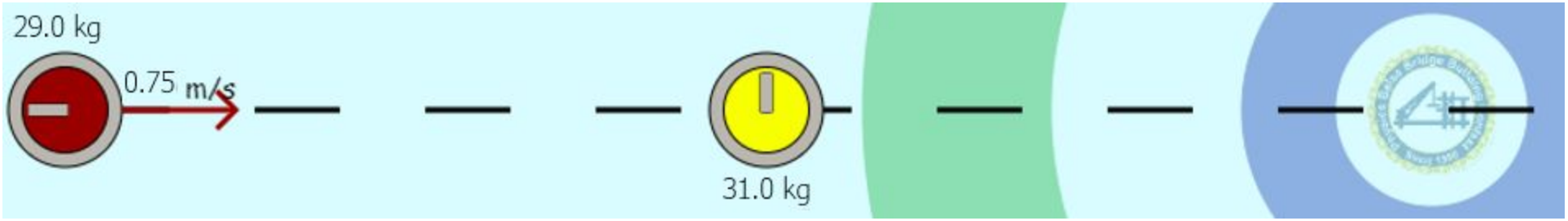
9-2b PhysAv Curling Stone Momentum Lab (honors)



BACKGROUND

As the red stone moves across the curling sheet it has **momentum** with units of kg·m·s^{-1}. Momentum is fundamental in analyzing collisions between cars and any objects that crash into each other. We calculate momentum with the product of mass and velocity, $m\vec{v}$. Once we know the objects mass and its current velocity, we know its momentum. Momentum is a vector; it has direction. Here we will analyze momentum in one-dimension.

The **law of conservation of momentum** states that the momentum of any system remains constant. That is to say that the initial momentum of a system is equal to its final momentum. In this simulation, we have two stones and both of their momenta contribute to the systems' total momentum. Here, we will test that law on the curling court.

GOALS

To *determine* and *compare* a systems' **momentum** before and after a collision.
To *confirm* or *deny* the **law of conservation of momentum**.

MATERIALS

computer with a web browser, calculator, a vibrant **text color** **(or highlighter),** and a **lab partner (possibly)**

SAFETY/CARE

If this was a live lab, involving curling stones and ice, we would wear closed toe shoes with sole spikes to protect our feet and give us traction.

NOTES

For all ***PSYW***, *please show your work* from **start to finish, equation to formula to substitution to answer.**

1. *Click* https://www.thephysicsaviary.com/Physics/Programs/Labs/CurlingStoneMomentumLab/, then **Begin**. This takes you to the *Physics Aviary Curling Stone Momentum Lab*.

2. First, *set* the **Vertical Separation of Centers to 0 cm**. Remember, we are working in **one-dimension** here.

3. *Define* the **independent variable** as either the **red mass (m_1)**, **yellow mass (m_2)**, or **red speed (u_1)**. *Write* this down with the **variable** and the **units**. NOTE: we will change this for each trial, while keeping everything else constant.

INDEPENDENT VARIABLE: _____ (___/___)

4. *Write down* the **dependent variable** as the **systems' momentum**, noting the **variable** and the **units**.

DEPENDENT VARIABLE: _____ (___/___)

5. *Write down* the **control variables** as the two remaining variables from #3. Be sure to express the **variable** and the **units**.

CONTROL VARIABLES: 1 _____ (___/___)

2 _____ (___/___)

6. Set the initial values for all variables. ***Do not use identical masses for the red and yellow stones.***
Further, for the independent variable, show each value that is being tested for all 6 trials (6 different values). Please check the range of possible values for each parameter (variable). ***We will use 3 SF throughout this experiment.***

INITIAL VALUES: **red mass (m_1)**: _____

yellow mass (m_2): _____

red speed (u_1): _____

7. There are two charts, one for initial momentum and another for final momentum. *Complete each chart as trials are completed*.

Initial							
	Red Stone			**Yellow Stone**			**System**
Trial	**Mass** (m_1/kg)	**Initial Velocity** (u_1/ms^{-1})	**Initial Momentum** $(p_{i1}/kgms^{-1})$	**Mass** (m_2/kg)	**Initial Velocity** (u_2/ms^{-1})	**Initial Momentum** $(p_{i2}/kgms^{-1})$	**Initial Momentum** $(p_i/kgms^{-1})$
1							
2							
3							
4							
5							
6							

*Remember that an object moving left will have a negative velocity.

8. Here, show a calculation for trial 4's initial momentum using $p_i = m_1u_1 + m_2u_2$ (formula, substitution, answer with units). ***PSYW***

Final							
	Red Stone			**Yellow Stone**			**System**
Trial	**Mass** (m_1/kg)	**Final Velocity** (v_1/ms^{-1})	**Final Momentum** $(p_{f1}/kgms^{-1})$	**Mass** (m_2/kg)	**Final Velocity** (v_2/ms^{-1})	**Final Momentum** $(p_{f2}/kgms^{-1})$	**Final Momentum** $(p_f/kgms^{-1})$
1							
2							
3							
4							
5							
6							

9. Please, determine trial 4's final momentum with $p_f = m_1v_1 + m_2v_2$ (formula, substitution, answer with units).* ***PSYW***

10. For each trial, *determine* the **percent difference** between the **initial** and **final momenta**. Use $\%difference = \frac{|initial - final|}{\left(\frac{initial+final}{2}\right)} \cdot 100\%$.

PSYW for trial 4.

Trial	Initial Momentum ($p_i / kgms^{-1}$)	Final Momentum ($p_f / kgms^{-1}$)	Percent Difference of Initial and Final Momenta
1			
2			
3			
4			
5			
6			

QUESTIONS

Q1: Do the results ***confirm or deny*** the validity of the law of conservation of momentum?

[*Use your own words* to answer this question *with at least two sentences*.]

[*Justify* this answer using *three forms of evidence* from this lab report.]

[Another calculation may be added above to affirm this answer.]

[Solid evidence may include: maximum & minimum momentum differences ('best' and 'worst' trials), mean of the momentum difference, range of the momentum differences, range of the percent differences, mean of the percent difference, or even a graph of final v. initial momenta]

Using anecdotal data is called **cherry-picking. This is where one trial's data is shown, usually to convey confirmation of a hypothesis.

Q2: *Describe* another method to ***test the law of conservation of momentum***?

[*Write* at least **four sentences**.]

[*Describe* the experimental **set-up** and possible sensors.]

[*Explain* the **event** being measured]

[*Share how* this experiment can **prove or disprove** the law of conservation of momentum.]

[Get creative; think big; think small; think out of the box.]