NAME: ____________ AP PHYSICS 1 DATE: ____________

PROJECTILE LAUNCHER – DATA COLLECTION

DAY 3 — COLLECT DATA

TODAY'S GOAL

Measure the spring constant k and launch velocities for your projectile launcher. Tomorrow you'll use energy conservation to check if the "stored work" in the spring correctly predicts these speeds.

PART A — FIND K FOR YOUR LAUNCHER

DATA **Force vs. Compression**

Push the plunger with a digital force meter at each click position. Your launcher has 3 settings.

Click Position	Compression x (m)	Force F (N)
0 (relaxed)	0	0
1 (short)		
2 (medium)		
3 (long)		

GRAPH **Plot F vs. x and Find the Slope**

Plot your data below. Draw a best-fit line through the origin. The slope is your spring constant k.

RESULT

$k =$ ____________ N/m

Launcher #: ____________

Ball mass: $m =$ ____________ kg

Group members: ____________

PART B — MEASURE LAUNCH VELOCITIES

Safety: Always aim the launcher into the collection box. Never look down the barrel. Wear safety glasses.

METHOD Choose Your Measurement Technique

Circle the method your group is using:

Video Analysis | **Projectile Range** | **Photogate**

Briefly describe your setup:

DATA Measured Velocities

Launch the ball at each compression setting. Run 3 trials per setting and record the exit speed.

Position	Compression x (m)	Trial 1 v (m/s)	Trial 2 v (m/s)	Trial 3 v (m/s)	$\bar{v}_{measured}$ (avg)
1 (short)					
2 (medium)					
3 (long)					

OBSERVE Quick Pattern Check

Look at your velocity data. When you increased the compression, did the velocity increase proportionally?

Ratio of compressions:

$$\frac{x_3}{x_1} = \_\_\_\_\_\_\_\_$$

Ratio of velocities:

$$\frac{v_3}{v_1} = \_\_\_\_\_\_\_\_$$

What pattern do you notice? Are these ratios equal?

Keep this page! Tomorrow you'll use energy ideas to *predict* what these velocities should be, then compare to your measurements.

DAY 4 — ENERGY CHECK

THE PREDICTION

If **all** the spring's stored energy converts to kinetic energy of the ball:

$$\frac{1}{2}kx^2 = \frac{1}{2}mv^2 \quad \Rightarrow \quad v_{predicted} = x\sqrt{\frac{k}{m}}$$

Assumes: no friction, no energy lost to sound/heat, ball leaves spring at full speed.

PART C — PREDICT LAUNCH SPEEDS

Use your Day 3 values: $k =$ _______ N/m $m =$ _______ kg

PREDICT Sample Calculation — Position 1

Show your full work for Position 1 using $v = x\sqrt{k/m}$:

PREDICT Complete the Prediction Table

Position	Compression x (m)	$v_{predicted}$ (m/s)	$\bar{v}_{measured}$ (from Day 3)
1 (short)			
2 (medium)			
3 (long)			

CHECK Ratio Test

The model says $v \propto x$ (velocity is proportional to compression). Even if your absolute values are off, do the *ratios* match?

Predicted ratio:

$\frac{v_3}{v_1} =$ _______________

Measured ratio:

$\frac{v_3}{v_1} =$ _______________

Do the ratios agree? What does this tell you about the model?

PART D — COMPARE PREDICTION TO MEASUREMENT

ANALYSIS Percent Difference

Calculate the percent difference between your predicted and measured velocities.

Position	$v_{predicted}$ (m/s)	$\bar{v}_{measured}$ (m/s)	% Difference
1 (short)			
2 (medium)			
3 (long)			

Formula: $$\% \text{ Difference} = \frac{|v_{predicted} - v_{measured}|}{v_{predicted}} \times 100\%$$

Show one sample % difference calculation:

EVALUATE Sources of Discrepancy

If $v_{measured} < v_{predicted}$, list at least two possible sources of energy loss:

If $v_{measured} > v_{predicted}$, what might explain that? (Think about your k measurement.)

CONCLUSION Does Energy Conservation Work?

Based on your data, does $\frac{1}{2}kx^2 = \frac{1}{2}mv^2$ accurately predict launch speed? Write 3–4 sentences citing specific evidence.

✓ **Key Takeaway:** Even if individual measurements have some error, $v \propto x$ should hold — that's the power of energy conservation.