NAME: _____ AP PHYSICS 1 DATE: _____

WORK & ENERGY DAY 6: MIXED SYSTEMS

Warm-Up (3 min)

Fill in from memory (no peeking!):

Energy Type	Symbol	Formula
Kinetic		
Gravitational PE		
Elastic PE		

PROBLEM-SOLVING STRATEGY

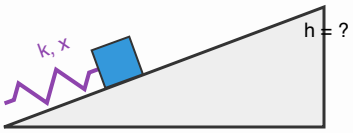
For every conservation problem:

1. **Identify initial and final states.** What's moving? What's stretched? How high?
2. **List energy accounts.** Which types are non-zero at each state?
3. **Write the equation:** $K_i + U_{g,i} + U_{s,i} = K_f + U_{g,f} + U_{s,f}$
4. **Cross out zeros.** (At rest? $K = 0$. On ground? $U_g = 0$. Relaxed spring? $U_s = 0$.)
5. **Solve for the unknown.**

TYPE 1: SPRING → HEIGHT (FRICTIONLESS)

WE DO Spring Launcher

A spring ($k = 800$ N/m) is compressed 0.15 m. A 0.50 kg block is placed against it and released. The block slides up a frictionless ramp. How high does it rise?



Given: $k = 800$ N/m, $x = 0.15$ m, $m = 0.50$ kg

Step 1: States

Initial: spring compressed, block at rest, $y = 0$

Final: spring relaxed, block at rest, $y = h$

Step 2: Equation

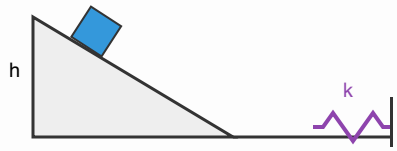
Step 3: Substitute and solve for h

Answer: $h =$ _____ m

PRACTICE: ENERGY CONVERSIONS (FRICTIONLESS)

WE DO **Block Compresses Spring**

A 2.0 kg block slides down a frictionless ramp from height $h = 0.80$ m. At the bottom, it collides with a spring ($k = 500$ N/m). How far does the spring compress?



Identify states:

Initial: _____

Final: _____

Write equation:

Given: $m = 2.0$ kg, $h = 0.80$ m, $k = 500$ N/m

Solve for x:

Answer: $x =$ _____ m

YOU DO **Practice: Kinetic → Height**

A ball is thrown straight up with an initial speed of 8.0 m/s. How high does it rise above the release point? (Ignore air resistance.)

Equation:

Calculation:

Answer: $h =$ _____ m

YOU DO **Practice: Height + Speed → Speed**

A 2.0 kg block starts at $h = 1.8$ m with an initial speed of 1.0 m/s down a frictionless ramp. What is its speed at the bottom?

Equation:

Calculation:

Answer: $v =$ _____ m/s

TYPE 3: MULTI-STEP PROBLEMS (FRICTIONLESS)

WE DO **The Full Journey**

A spring ($k = 600$ N/m) is compressed 0.20 m. It launches a 0.40 kg block up a frictionless ramp.

a. What is the block's speed just after leaving the spring (before climbing)?

b. How high up the ramp does it travel before stopping?

(a) Spring → Kinetic

Initial: compressed, at rest. Final: relaxed, moving.

$v =$ _____ m/s

(b) Kinetic → Height

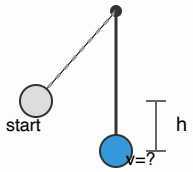
Initial: moving at v. Final: at rest, height h.

$h =$ _____ m

> **Shortcut:** You can skip the middle step! Go directly from U_s to U_g:
>
> $$\frac{1}{2}kx^2 = mgh$$
>
> Try it—you should get the same h.

YOU DO **Pendulum Speed**

A pendulum bob (mass 0.25 kg) is released from rest when the string makes an angle with vertical such that the bob is 0.40 m above its lowest point. Find the speed at the bottom of the swing.



Solve:

$v =$ _____ m/s

> **Common Mistake:** Students sometimes use the string length instead of the vertical height drop. Only the *vertical* change in position matters for U_g.

HOMEWORK

1 Conservation Check

A 0.20 kg ball is launched by a spring ($k = 500$ N/m) compressed 0.08 m up a frictionless ramp.

(a) Speed just after leaving the spring? (b) How high does it rise?

(a) $v =$ _____ m/s (b) $h =$ _____ m

2 Reverse Problem

A 1.5 kg block slides down a frictionless ramp from $h = 2.0$ m and compresses a spring ($k = 750$ N/m). Find the maximum compression.

Answer: $x =$ _____ m

3 Speed at a Height

A spring ($k = 800$ N/m) compressed 0.15 m launches a 0.50 kg block up a frictionless ramp. What is the block's speed at $h = 0.10$ m?

Answer: $v =$ _____ m/s

4 Moving Block Hits Spring

A 1.2 kg block sliding at 4.0 m/s on a frictionless floor hits a spring ($k = 600$ N/m). How far does it compress?

Answer: $x =$ _____ m

5 Challenge: Multiple Energy Types

A 0.60 kg block at $h = 0.80$ m with initial speed 3.0 m/s slides down a frictionless ramp and compresses a spring ($k = 500$ N/m). Find the maximum compression.

Answer: $x =$ _____ m