

POTW #1 - Systems

Similar to Newton's laws, work and energy are done for systems. That is, before starting with anything, we draw an imaginary box around a certain set of objects and define it as our "system".

Then, all the theorems derived prior (Work-energy theorem, Newton's laws, and such) all apply to this particular system. This problem of the week will explore how different systems may make calculations easier or harder.

Note that today's POTW will not cover work - we'll look into how systems play a role in that next week!

Newton's Laws

- (warmup) 1. Five boxes of masses m_1, m_2, \dots, m_5 are lined up along a surface with coefficient of friction μ_k with all five boxes in contact with one another. A net force F acts on the leftmost box.
- If all boxes accelerate uniformly with nonzero acceleration a , what is a ? (Hint: Let the system be all 5 of the boxes)
 - Suppose the blocks are connected with strings instead, with F acting on the right most block. Find the tension force in the 2nd string from the left
 - Solve part b. by considering each block individually.
2. A rod's left end is attached to the wall by some superglue. For any part of the rod, there are two forces on its left and right end in the perpendicular direction. These forces, known as shear forces, are used to maintain balance. It is an internal force, meaning that the shear force is due to some parts of the rod acting on other components (think: The tension force).

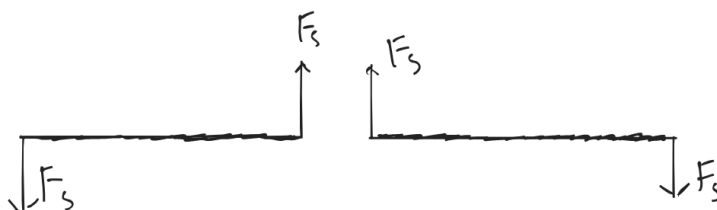


Figure 1: For the rod on the left, the shear force is defined to be negative. For the rod on the right, the shear force is defined to be positive. Note that the two shear forces acting on a rod are not necessarily equal.

- Suppose a rod of length l and mass per length λ has its left end glued to the wall. Let $S(x)$ be the shear force in the rod as a function of x , the distance from the left end. Express $S(x)$ in terms of x , λ , and Earth's gravitational acceleration, g .
- Suppose that the rod is now supported at its two ends by the same level support. Find $S(x)$ now.
- Solve part a. by considering a small piece of the rod with length Δx . Let this be your system. ¹

¹This is more challenging and thus is optional (Some familiarity with calculus will help)