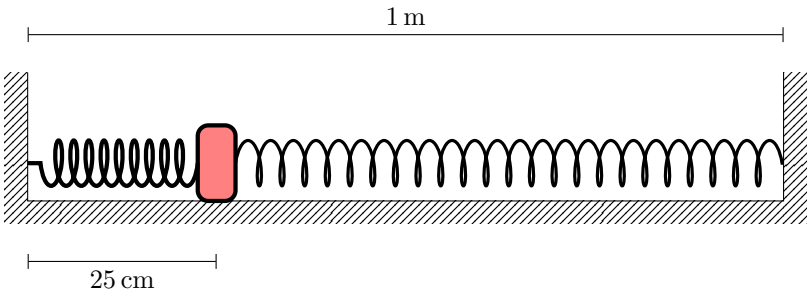
# 1 Objectives

Below are all the learning objectives summarized from the WebWorK or Video HW problems so far. These are in general what I will use to write the test problems.

- I understand basic vector notation and can perform simple vector calculations.
- I can transform between position, velocity, and momentum vectors and relate them to physical observations.
- I can utilize velocities at different time points to determine the net force corresponding to an interaction in three dimensions.
- I can use simplifying models and the momentum principle to determine the impact time and forces involved in an interaction.
- I can utilize the momentum principle and iteration method to determine the future positions of an object given initial conditions and forces.
- I can compute spring forces and use equilibrium positions to find effective spring constants.

# 2 Extra Problems

1. In the below image, the skinny block has a mass of 5 kg and is initially located 25 cm from the left wall. The left spring has a spring constant of 100 N/m and a relaxed length of 50 cm while the right spring has a spring constant of 20 N/m and a relaxed length of 25 cm. Given this information, answer the questions below.

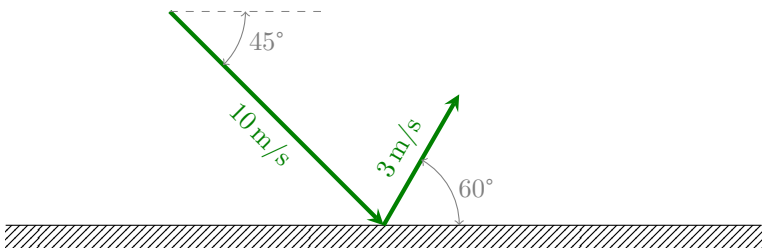



   (a) What is the initial net force acting on the block in the horizontal direction?

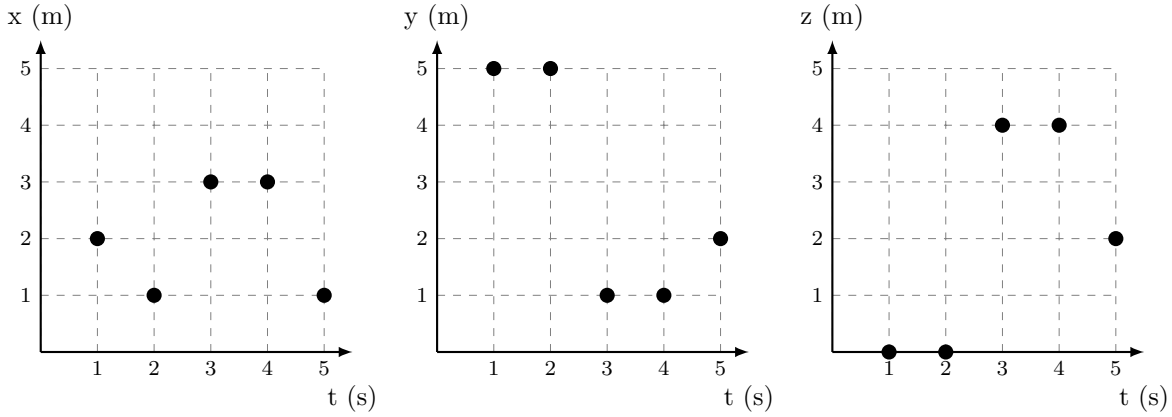
   (b) Taking time steps of 0.25 seconds, where is the block half a second later?

   (c) Where could the block be placed such that it would not move when released?

2. A ball strikes the ground while initial moving at 10 m/s at an angle of 45° below the horizontal. After the impact, the ball is traveling at 3 m/s at an angle of 60° above the horizontal. What unit vector points in the direction of the net force applied during the ball's collision with the ground?



3. The three plots below show the $x$, $y$, and $z$ position coordinates of a 2 kg object at different times. Use them to answer the below questions.




(a) During what time interval is the average velocity of the object 0?

(b) What is the average velocity between the 1st and 3rd second?

(c) Suppose at the 2 second mark some impulse acted on the particle? Using the average velocities from the intervals immediately before and after this point, estimate the magnitude of the impulse.

# 3 Solutions

**Problem 1** I'm just going to include the final values here, if you are struggling to replicate them, check with me, as it is always possible I made a mistake as these are newly created problems.

1. $\langle 35, 0, 0 \rangle$ N
2. 90.6 cm from the left edge
3. 54.2 cm from the left edge

**Problem 2** $\langle -0.499, 0.866, 0 \rangle$ Units don't really make sense on a unit vector since it is really only conveying direction. Don't forget if using direction cosines that it is always the angle from the *positive* axis to the vector in question!

**Problem 3** This may look different from other things you've seen, but it contains all the same information!

1. From 3 to 4 seconds, as none of the positions in any dimension shifted during that time
2. $\vec{\mathbf{v}}_{avg} = \langle 0.5, -2, 2 \rangle$ m/s
3. 12.81 N s