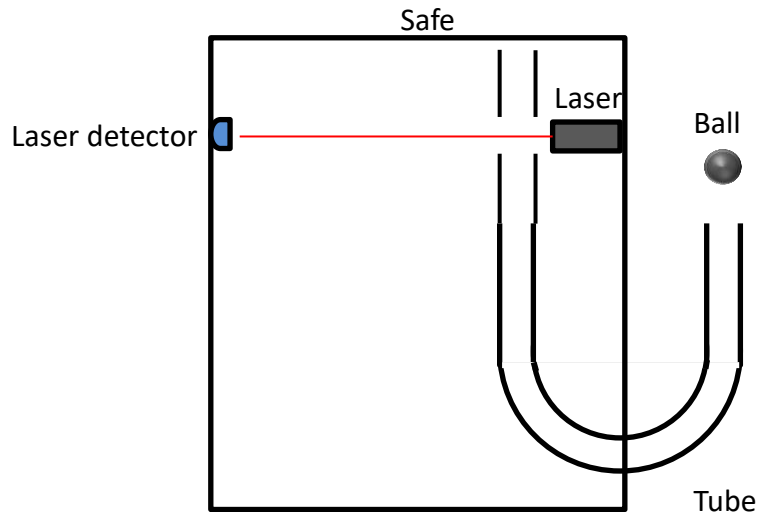


The following examples will explain the ways to use a physical principle in a safe riddle.

A riddle can use simple principles, like basic mechanics. However, this is a very simple example, and we expect the teams to use more sophisticated ideas and riddles.

In this example we chose to use gravity and the transition between potential energy to kinetic energy:

Assume we have a ball and a curved tube, as shown in the figure.



We will begin with a good riddle:



The burglars' goal is to block the laser beam for as long as they can for the lock to open. When the detector does not "see" the laser light for a certain amount of time, the lock opens. The burglars need to understand that they should drop the ball from approximately the same height as the laser. If so, the ball would reach velocity 0 in front of the laser and block it for longer time. Too high – the ball will pass the laser twice and too quickly. Too low – the ball would not reach the laser. Here, the burglars must be familiar with motion under constant gravitational acceleration and the transition from potential energy to kinetic energy and the other way around. The puzzle needs to still work even if the height is not exact, so just understanding the principle is enough, and great accuracy in the height is less important. Note that if the burglars understand the physics, they do not need to guess, and do not need to try more than once.

Now, we will introduce bad variations of this riddle:



The burglars need to find the exact height to drop the ball from so the laser is blocked for exactly 0.5 seconds. Whether this 0.5 sec time interval is known to the

burglars or not, this is no good because the only way to do that is to guess and use trial and error strategy. In this sense, it is like a combination lock, but instead of numbers there is a block time. The only way to crack a combination lock is to know its code, or trial and error, and the same here. This applies to puzzles like a mirror maze (where a laser beam needs to be navigated towards a detector using rotating mirrors) where only one combination of mirror angle will work, like finding the right resistor to put so the right current (not known to begin with) will go through a circuit and so on.



The burglars need to find a ball in a box of many objects, all in the same color, and then block the laser with it. This is not allowed because the objects the burglars need to use need to be known to them, and not hidden. If they are not available, and a first riddle needs to be solved in order to get them, that is fine, as long as the burglars know that this is the case.



The burglars get the mass of the ball, its radius, the air and tube friction constant, the height of the laser and other numbers, and they need to calculate the right height to drop the ball from so the laser will be blocked exactly 0.5 sec. This is not a good puzzle because we aim at experimental physics competition. This looks more like a problem you get in your homework. This is equivalent to calculating the right resistance to put in an electric circuit, find the spring constant of a spring, calculation using the refraction index of a material and so on.



The burglars need to find some way to block the laser, when they get a ball. This is simply too easy and relies on everyday intuition and not on physical knowledge. Everyone knows that the ball will roll down and then up the tube and can block the laser after that. This is equivalent again to a mirror maze, where everyone knows that laser light will reflect from a mirror, and even if people do not think of that, they have enough intuition to direct the angle of the mirror so the laser will be reflected in the end to the desired direction.



The burglars get a set of multiple-choice questions, with the right answers' letters allow them to open a combination lock, which locks a box where the ball can be found.

This is just not the idea of the competition. We aim for an experimental physics competition, and therefore we do not want to test your knowledge of general theoretical physics. This is equivalent to any type of non-physics questions, like resistor color code, binary numbers calculation, or physics questions, like: if dropped from the tower of Pisa (say, in vacuum), which will hit the ground first, a feather or an iron ball?

Please remember the guideline:

***A good safe is one that when the physics behind it is understood (no trial and error! No pen and paper calculation!), its opening should take no longer than two minutes. However, if the physics riddle is not understood, it will be hard (even impossible!) to open it, no matter how much trial and error are involved.***

This guideline has two parts, both of equal importance: not opening without understanding, and with understanding – easy opening!