

NAME

1. In the plinko applet explain why the balls fall in the pattern shown.

The number of ways to reach a given bin is proportional to the probability of going into that bin.

2. Explain how the self inductance varies with the number of turns.

$$\frac{\Phi_{\text{tot}}}{B} = LI \quad \frac{\Phi_{\text{tot}}}{B} = N \frac{\Phi_{\text{one}}}{B} \quad \frac{\Phi_{\text{one}}}{B} = \int \vec{B} \cdot d\vec{a} \quad B \propto N$$

so  $L = \frac{\Phi_{\text{tot}}}{I} \propto N^2$

3. A rail gun is constructed as shown. Derive an expression for how the circuit behaves and another one for how the rail moves. Please make explicit the dependence of each parameter in these equations on other variables. That is, if a capacitance appears as  $C$  then I interpret that as it having no other dependence (for example time, voltage, etc.).

$$\text{Emf}_{\text{back}} = - \frac{d\Phi_B}{dt} = - \frac{d}{dt} \left( \vec{B}_{\text{static}} + \vec{B}_{\text{current}} \right) \cdot d\vec{a}$$

$$= - \frac{d}{dt} (B_{\text{static}} L x) - L \frac{dI}{dt} = -B_{\text{static}} L v - L \frac{dI}{dt}$$

$$\boxed{12V - IR - B_{\text{static}} L v - L \frac{dI}{dt} = 0}$$

$$\boxed{F = ILB = m \frac{dv}{dt}}$$

$L$  depends on shape of the loop which varies with time. Not so easy to find  $L(t)$