Notes on the friction lab

Physics 201

In this lab we will examine impact speed and stopping distance in different materials

- We have studied friction in class, where the friction force is proportional to μN, where the coefficient of friction (μ) depends on whether an object is moving or stationary.
- This is a good description for the interaction of an object with a solid surface, but it does not describe the friction force experienced in a material that is more fluid-like.
- We might like to know, for example, whether rice behaves like a fluid or like a solid.
- We don't have some kind of adjustable-speed cannon, so we are going to drop objects from various heights to get a range of of impact speeds.

Your job is to assess each material:

Step 1: The first thing you need to do is to understand the relationship between impact speed and drop height. Before doing anything else, since this is central to the rest of this lab, derive this relationship from either kinematics or force analysis.

Step 2: Further analysis of the different kinds of friction forces acting on the ball as it slows in a material shows that the stopping distance in the material ($D_{stopping}$) has a different relationship to the impact speed depending on whether the material acts with a force more like the contact friction we studied in class or more like fluid friction (drag).

- If the material acts with something like a contact friction force then we should see $D_{stopping} \propto v_{impact}^2$.
- If the material acts with something like a fluid friction force then we should see $D_{stopping} \propto v_{impact}$.
- Does the material behave in some other way? If so, describe how it behaves and try to justify your observations and reasoning.

First, we need to format our data

In Excel:

	A	B	C	D
1			Popcorn	Crispies
2	drop height [cm]	speed [cm/s]	depth [cm]	depth [cm]
3	90	420.0	7.5	6.0
4	90	420.0	5.8	6.8
5	90	420.0	5.0	6.0
6	90	420.0	3.5	6.2
7	90	420.0	6.0	5.5
8	120	485.0	4.0	7.3
9	120	485.0	4.0	6.9
10	120	485.0	6.0	7.0
11	120	485.0	6.2	7.1
12	120	485.0	4.5	9.0
13	150	542.2	7.5	8.7
14	150	542.2	7.0	7.4
15	150	542.2	4.2	8.2
16	150	542.2	5.0	7.5
17	150	542.2	7.0	7.8
18	170	577.2	5.1	8.5
19	170	577.2	8.0	9.7
20	170	577.2	5.0	8.6
21	170	577.2	7.0	9.5
22	170	577.2	7.0	9.5
23	200	626.1	4.0	8.0
24	200	626.1	8.0	8.0
25	200	626.1	8.0	9.0
26	200	626.1	7.5	9.5
27	200	626.1	7.0	10.5

Comments:

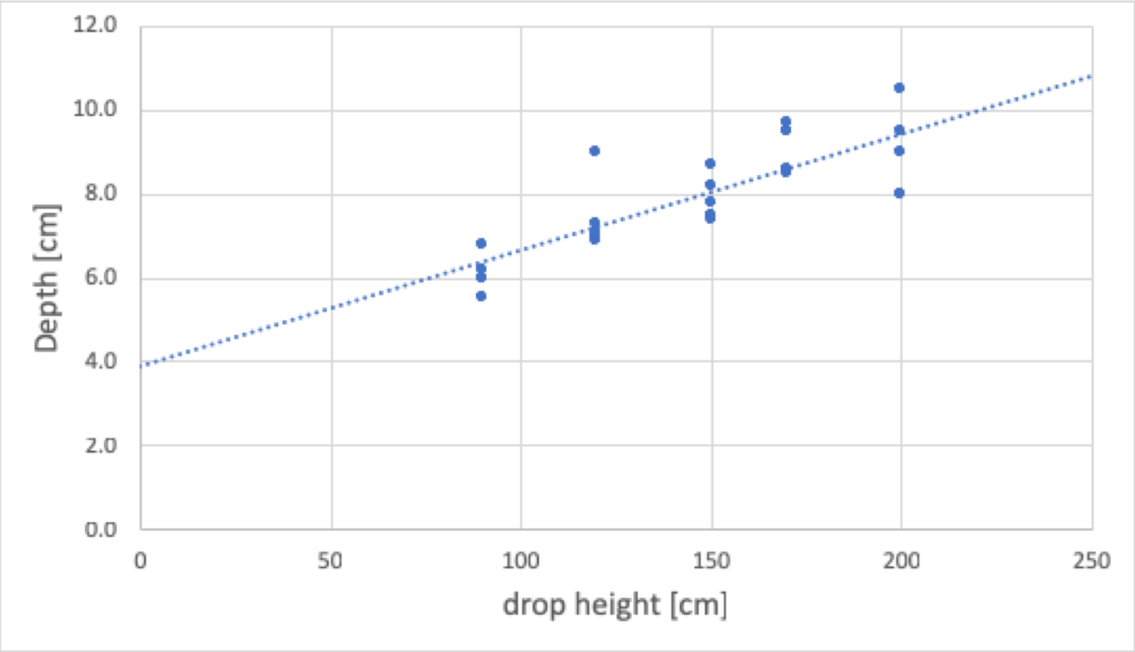
- I am no Excel wizard, so you might have better ways of doing things, which is fine.
- Though it is somewhat redundant, the easiest way to set up the data table is to record the drop height for each trial.
- We are going to want to compare against both v_{impact} and v_{impact}^2 (which you can express in terms of the drop height).
- Can calculate the speed of impact using an equation:

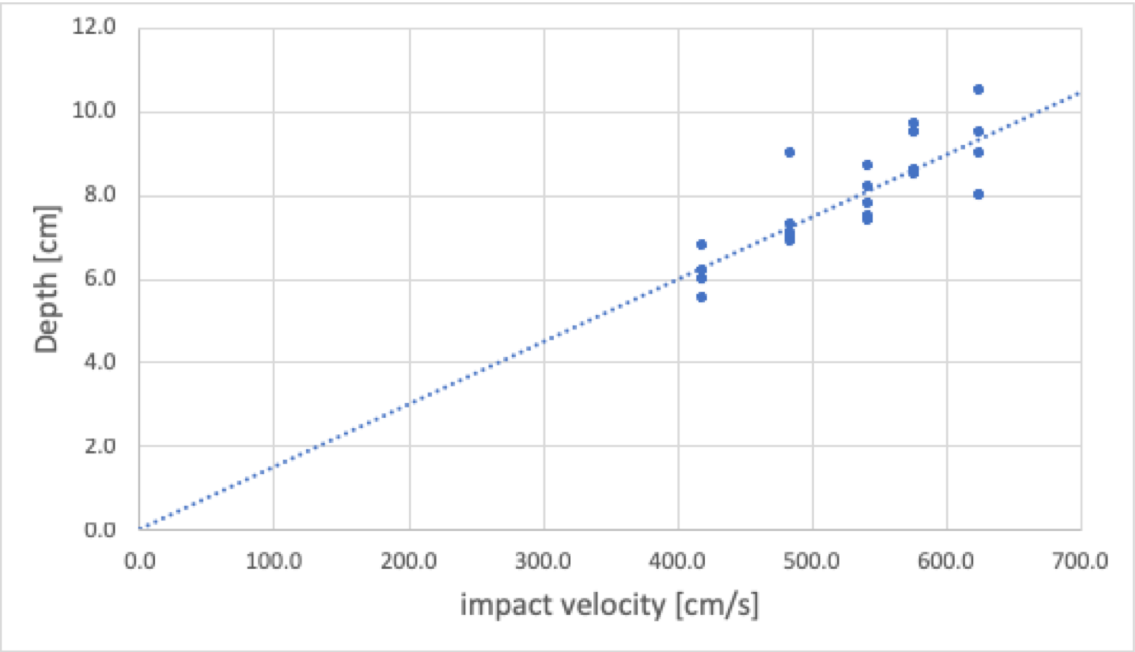
fx =SQRT(2*100*9.8*A3)

B	C	D
	Popcorn	Crispies

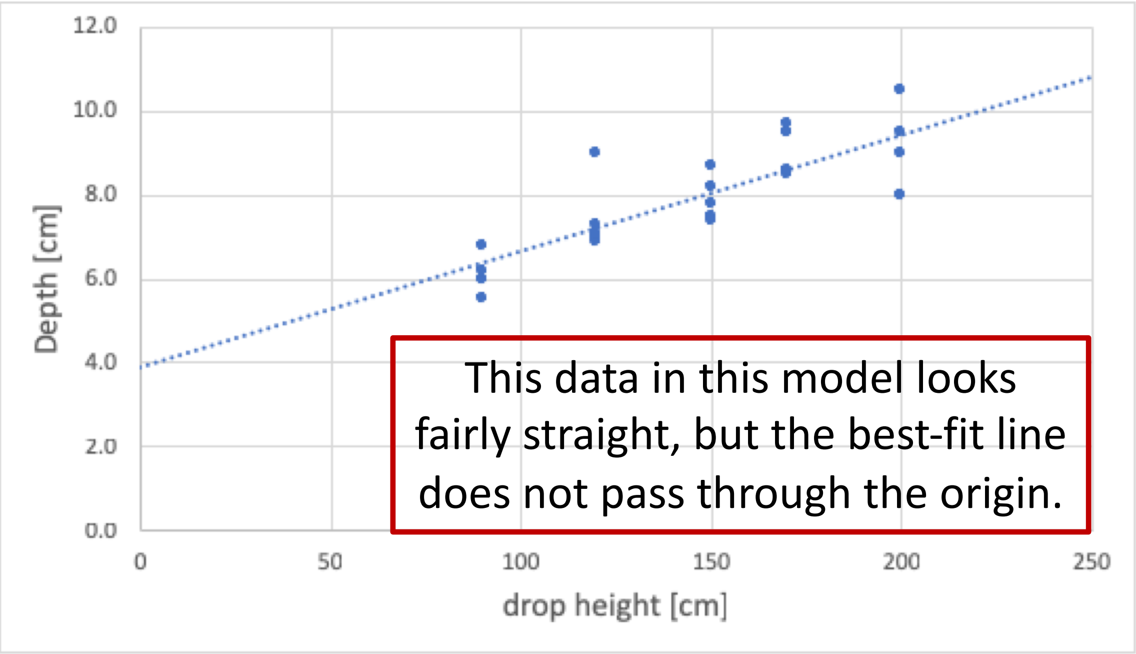
Why this equation, and why is the factor of 100 in there?

Which model is better?

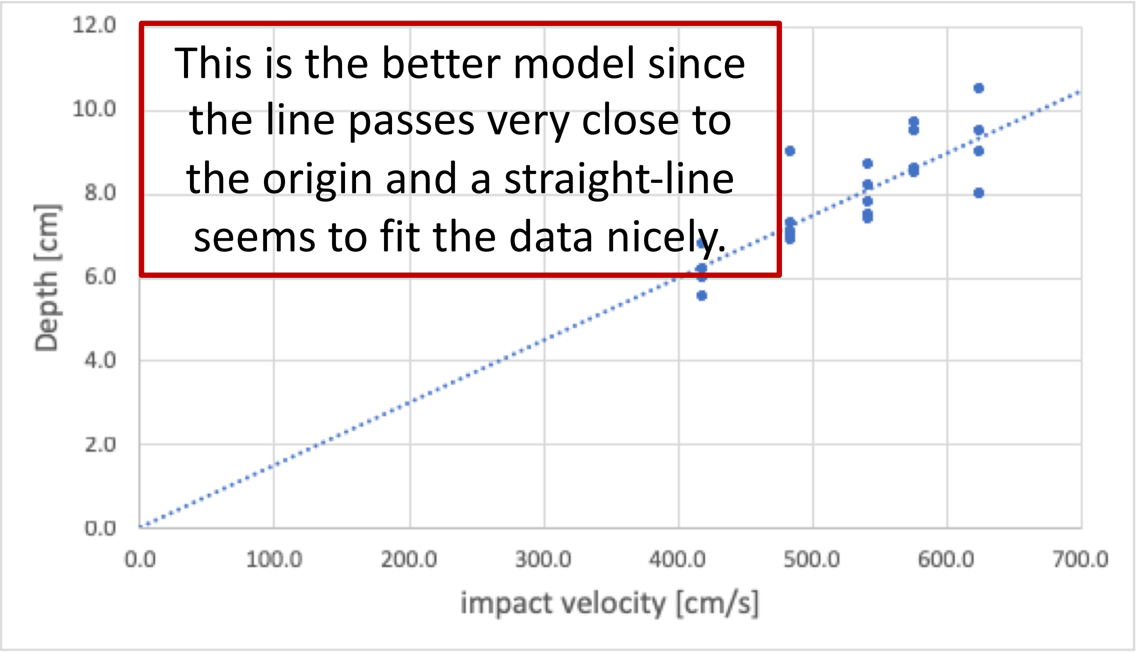




Which model is better?



This data in this model looks fairly straight, but the best-fit line does not pass through the origin.



This is the better model since the line passes very close to the origin and a straight-line seems to fit the data nicely.

Therefore, we should characterize this material as acting more like a fluid.