

## If the shoe fits: Worksheet answers

### Part 1 Scientific Questions

When scientists and engineers ask a scientific question, they make a prediction: ***If this thing is changed, then that is expected to happen.*** In testing that prediction, they try to keep all other factors unchanged.

Suggest a couple of scientific questions that you could ask using your experiment equipment and materials:

- 1) How shoes response to different levels of friction.
- 2) Which types of shoes will be the most resistant to friction.

Some Scientific questions will be more suitable for investigation in a classroom setting. Your teacher will lead a discussion to decide which scientific question will be investigated. Your group will then decide how to investigate that question.

The Scientific question that my group will investigate is:

To discover how friction affects the amount of work used to slide a shoe across a surface.

Our hypothesis is:

I think the studded shoe will be the most resistance and rubber 1 the least.  
I think that grass will have the most friction, and concrete the least.

Our **Independent** variable is (What you changed):

The surfaces, shoes and weights.

Our **Dependant** variable is (what you measured):

The force used to move the shoes across different surfaces.

Our **controlled variables** are (what did you keep the same):

As the surfaces and shoes were changed the only controlled variable is the friction present on the different surfaces.

Are there any **safety** issues to consider?

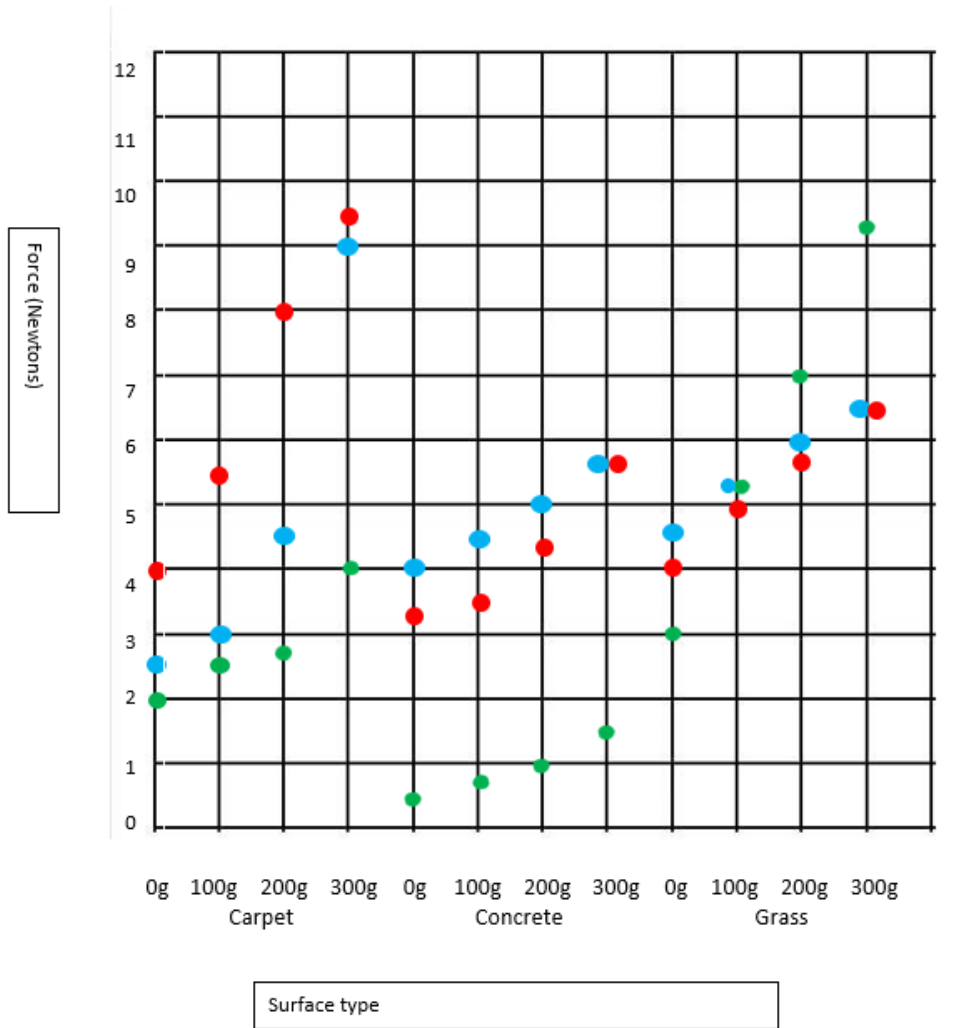
No

## Part 2 Testing our scientific question

Get approval from your teacher of your plans (Part 1) before starting Part 2.

Shoe type	Surface Type	Weight	Friction Force (newton)
Studded	Carpet	0g	2 N
		100 g	2.5 N
		200 g	2.75 N
		300 g	4 N
	Concrete	0 g	0.5 N
		100 g	0.75 N
		200 g	1 N
		300 g	1.5 N
	Grass	0 g	3 N
		100 g	5.25 N
		200 g	7 N
		300 g	9.25 N
Rubber 1	Carpet	0 g	2.5 N
		100 g	3 N
		200 g	4.5 N
		300 g	9 N
	Concrete	0 g	4 N
		100 g	4.5 N
		200 g	5 N
		300 g	5.75 N
	Grass	0 g	4.75 N
		100 g	5.25 N
		200 g	6 N
		300 g	6.5 N
Rubber 2	Carpet	0 g	4 N
		100 g	5.5 N
		200 g	8 N
		300 g	9.5 N
	Concrete	0 g	3.25 N
		100 g	3.5 N
		200 g	4.25 N
		300 g	5.75 N
	Grass	0g	4 N
		100 g	5 N
		200 g	5.75 N
		300 g	6.5 N

**Graph: Use different colours for each shoe and graph surface type vs friction force**



Colour of shoe:

Shoe 1: A studded shoe used in sports. **Studded**

Shoe 2: A canvas shoe with a rubber sole. **Rubber 1**

Shoe 3: A leather working boot with a rubber sole. **Rubber 2**

## Part 3: Discussion

What do the trends in the graph mean?

The trends show which surface has the most friction. As the surface will more friction required more work to move the shoes across them

What shoe type performed the best on average?

Average for Studded.  $(2+2.5+2.75+4+0.5+0.75+1+1.5+3+5.25+7+9.25)/12 = 3.29$   
Average for Rubber 1  $(2.5+3+4.5+9+4+4.5+5+5.75+4.75+5.25+6+6.5)/12 = 5.06$   
Average for Rubber 2  $(4+5.5+8+9.5+3.25+3.5+4.25+5.75+4+5+5.75+6.5)/12 = 5.41$   
Rubber 2 has the most resistance. Studded had the least resistance

Which material had the most friction?

Average for Carpet  $(2+2.5+2.75+4+2.5+3+4.5+9+4+5.5+8+9.5)/12 = 4.77$   
Average for Concrete  $(0.5+0.75+1+1.5+4+4.5+5+5.75+3.25+3.5+4.25+5.75)/12 = 3.31$   
Average for Grass  $(3+5.25+7+9.25+4.75+5.25+6+6.5+5+5.75+6.5)/12 = 5.36$   
The grass has the most friction. The concrete had the least amount of friction

What could have caused your data to not be reliable?

Mistakes reading the spring balance wrong or using it incorrectly. Also any jerking motion may make getting a repeatable measurement difficult.

## Part 4: Reflection

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Did your observations or measurements agree with your expectations and prediction? Can you explain why?

The studded shoes showed more resistance on the grass than other surfaces. This was expected as it what studded shoes are designed for.

The rubber shoes overall have similar levels of resistance.

Did you encounter any problems?

We spent a bit of time figuring out the best way to attach and use the spring balance.

It was difficult to move the shoes at the same speed.

What changes could you have made to this experiment?

No changes were necessary to be made.

What did you discover for this experiment?

The different shoes will react differentially to different surfaces.

## Conclusion

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The hypothesis for the surfaces was proven correct. While the hypothesis for the shoes proven incorrect as the studded shoe was the least resistance.

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