Name: ____ *Class:* _______

Tutorial: Pushes and pulls

Forces and shapes

1. Take a piece of blu-tack and place it on the bench.

   Can you change the shape of the piece? In the space below draw the blu–tack before you started and draw its new shape.

2. Describe what you did to change the shape of the blu-tack.

   ____

   ____

3. Pictures can be used to represent actions. In the space below draw a picture of what you did to change the shape of the blu-tack.

4. Make a list of four other actions you could have used to change the shape of the piece of blu-tack.

A force was applied to the blu-tack.

A force can cause a change of shape.

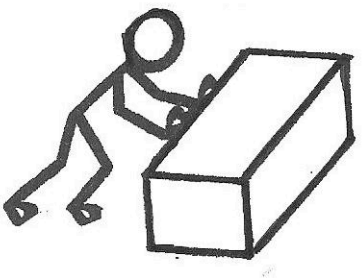
5. Look at the actions described in Question 4. Most forces are either a PUSH or a PULL.

   Decide which of the actions listed are a PUSH and which are a PULL.

push	pull

Most forces are pushes or pulls.

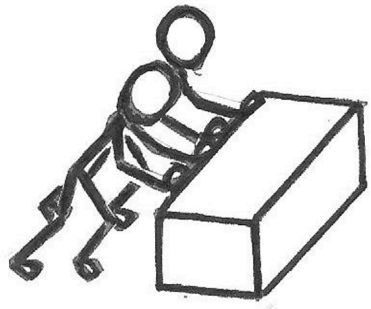
6. Arrows can be used to represent forces. Draw an arrow to represent the push force the boy exerts on the box.



   As the boy pushes the box it slides along the ground, and it speeds up a little.

A force can change how an object moves.

7. While the box is moving, a friend comes over to help. He pushes as hard as the first boy. Draw one or more arrows to represent the PUSH force on the box now.

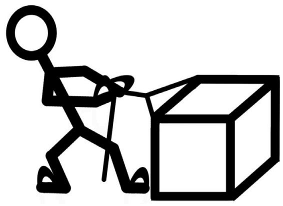


What is different about the arrows now?

Will the box move the same as when just one boy was pushing? Explain your answer.

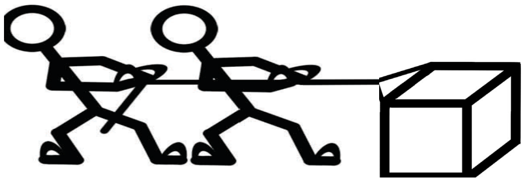
8. The first boy now pulls on the rope as hard as he was pushing the box before.

Draw an arrow to represent the PULL force on the box.



Remember: a force can change how an object moves. What can you say about how the box moves now?

9. Draw one or more arrows to represent the PULL force on the box now. Each boy pulls as hard as before!



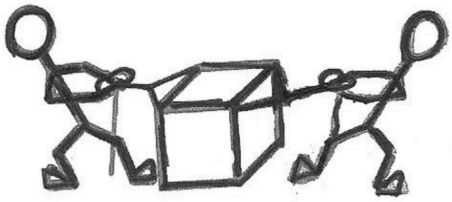
Is the PULL force any different from before?

Are the arrows different when one or two boys are pulling? If it is, explain WHY there is a difference.

Do you think the box will move? If you think the box will move, will it move the same as in Question 8?

Explain your answer.

10. Draw arrows to represent the PULL forces on the box. Each boy pulls as hard as the other!



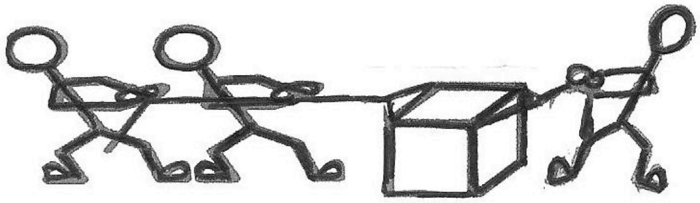
How many arrows did you draw?

Explain in what way the arrows are the same, and how they are different.

Do you think these pull forces change how the box moves?

Explain your answer.

11. Draw arrows to represent the PULL forces on the box now.



Do these pull forces change how the box moves?

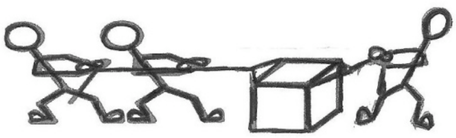
Explain your answer.

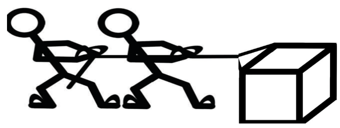
A Force can change how an object moves.

If a Force does not change how an object moves,
then there must be another force of equal size acting against it.

Homework Question

1. Consider the two situations shown below.





Use force arrows to help explain why and how the two boxes move differently.

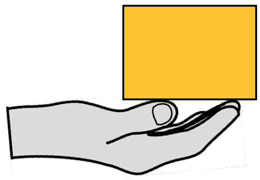
Tutorial: Weight

1. From now on, we will represent a bigger force by a longer arrow.

   Compare this to the representation you used. If they are different, can they show the same things?

   If a force was twice as big as another, how would you show that in the arrows?

2. A man balances a box on his hand as shown.



   What happens to the box if the hand is removed?

   Does the box move differently when the hand is removed?

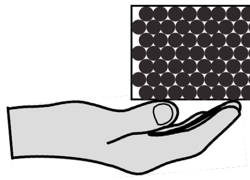
   What makes an object move differently?

3. Draw an arrow to represent the force acting on the box when the hand is removed.

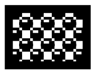
   What do you think causes this force?

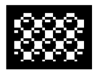
   Draw an arrow for the force of the hand on the box (before you removed it). Explain how you drew it.

4. The man now holds the same box filled with marbles as shown.



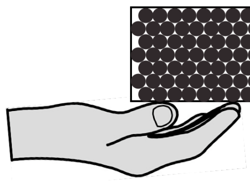
Draw an arrow to show the force acting downwards (i) before, and (ii) after the hand is removed.





Are the forces bigger, smaller or the same as in Question 2? Explain.

5. An astronaut holds the same box, filled with marbles, while standing on the moon.



What happens to the box when the astronaut removes her hand?

Does the box move differently?

Draw an arrow to represent the force acting on the box when the astronaut's hand is removed.

Is your arrow the same as in Question 3? If the arrow is different explain WHY you think it should be different.

WEIGHT is the force that makes the box move when the hand is removed.

WEIGHT depends on the mass of an object.

WEIGHT is the force of gravity,
which is greater on Earth than on the Moon.

weight = mass × g (on Earth: weight in N = mass in kg × 10)

Homework Questions

1. Weight is a force, so what unit is used for weight?

2. A box has a mass of 5 kg. What is its weight on Earth?

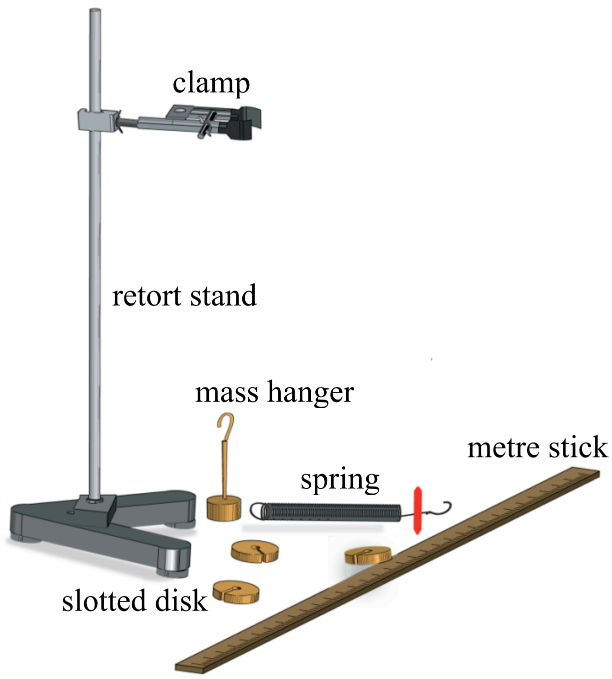
3. A box is hung from a spring as shown.

If the weight of the box (which is a force) is acting downwards, why does the box not start to move downwards?

Experiment: Making a spring balance

Optional questions are printed in **bold**.

In this experiment, you will investigate how a spring extends (gets longer) when different masses are hung from it.



1. Pick up the spring, and hang different masses on it. What do you notice?

____
____
____
____
____

2. Draw the spring below in two different situations: (a) when no mass is hanging on it, and (b) when there is a mass hanging on it.

   Show in diagram (b) how much the spring has stretched.

(a) no mass hanging from the spring	(b) mass hanging from the spring

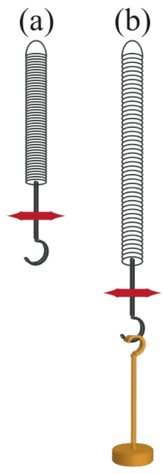
3. The diagram shows a spring before and after a mass hanger is attached.

   Use a ruler to measure, **on the diagram** at right:

   The length of the unextended spring, (a): __________

   The length of the extended spring, (b): __________

   Now calculate the extension of the spring: __________



4. Compare your answers in Question 3 with those from another group. Did you get the same answer for the extension of the spring?

   ____

   Did you get the same answers for the lengths of the spring?

   ____

   Explain how some people might have different answers for the length of the spring, but still get the same answer for the extension.

   ____

   ____

5. Hang the spring on the retort clamp, and measure the length before and after you put the mass hanger on.

   The length of the unextended spring: ____________

   The length of the extended spring: ____________

   Now calculate the extension of the spring: ____________

6. When the mass hanger is hanging still on the spring, what forces are pulling and what forces are pushing on it? Draw a diagram to show these forces.

   ____

   What happens to the forces on the spring when you put one of the disks on the mass hanger?

   ____

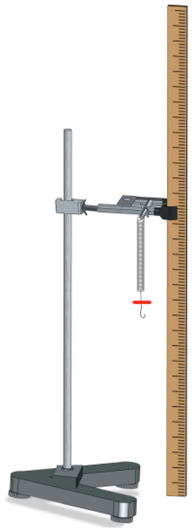
   ____

   Explain this statement: "When the spring gets longer, the spring pulls harder".

   ____

   ____

7. Look at the set-up shown in the diagram. How could you use it to measure how the extension of the spring changes when it applies different forces?



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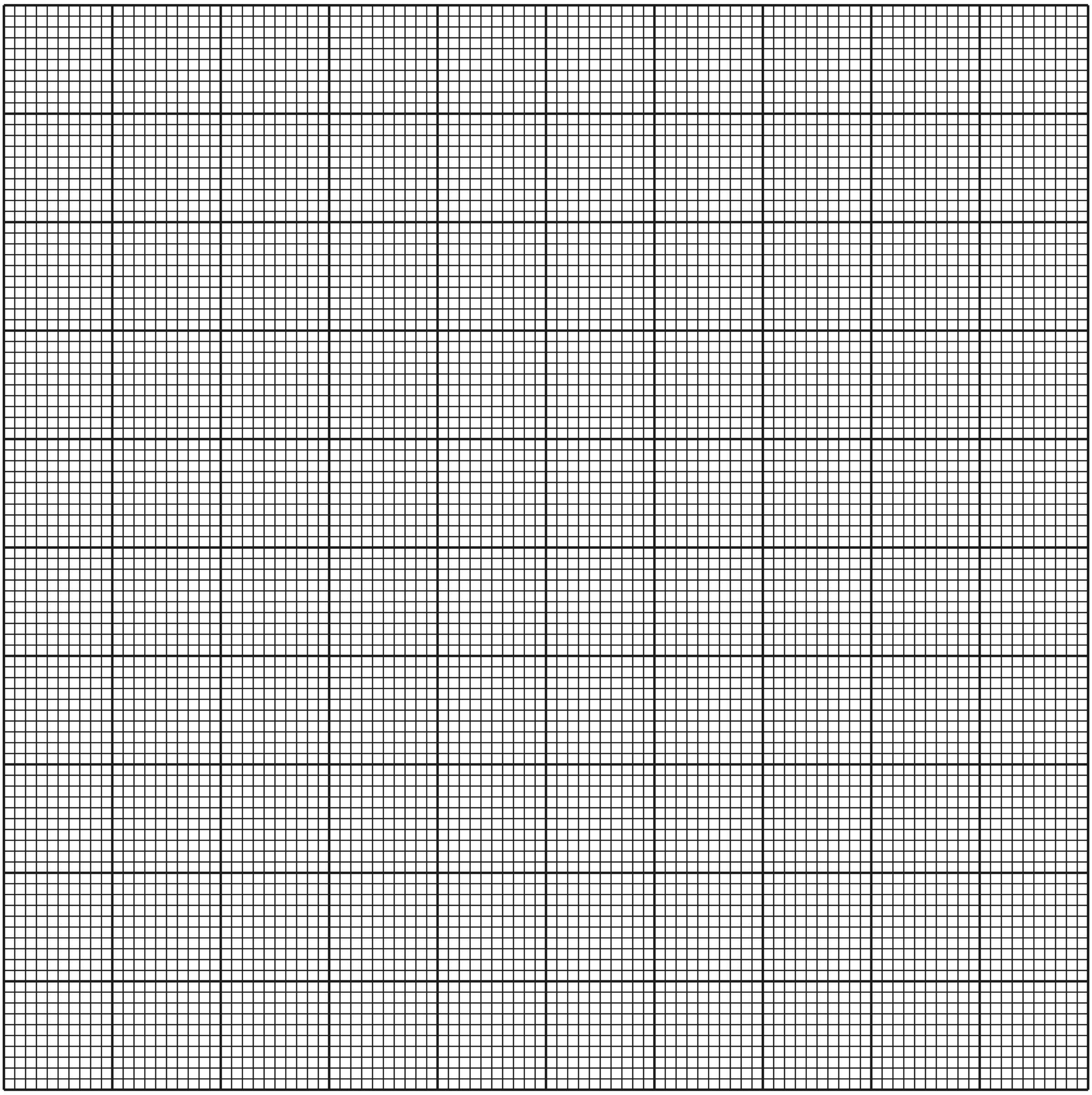
8. Set up the experiment, and complete Table 1. You should make a measurement for each mass you add to the spring. If you are not sure of the mass of the hanger or the disks, ask your teacher. Remember that the force of gravity is 1 N for every 100 g.

Table 1: The length of the spring for each mass added and the extension of the spring.

	spring only	spring with hanger	1 disc added					
total mass added (g)	0							
applied force (N)	0							
length (cm)								
extension (cm)	0							

9. Plot a graph for the **extension** (**not** the length) of the spring against the force applied. Plot the force on the horizontal axis (x-axis) and the extension on the vertical axis (y-axis).



10. Remove the mass hanger, and hang an object such as a set of keys or a heavy pen on the spring. Measure the length and extension of the spring and then fill in your results in Table 2.

Table 2: The length of the spring and its extension for the object you added.

object	length (cm)	extension (cm)

Use your graph on the previous page to determine the force the spring exerts on the object.

___

___

Determine the mass of the object. Show your work.

___

___

11. Measure the mass of the same object with a mass balance.

___

How do the two values for the mass compare?

___

Homework Questions

1. Springs are used in everyday life. Give an example of where have you seen springs used.

   ____

   ____

   In this example, what made the spring useful?

   ____

   ____

2. Answer the following questions on forces:

   a. What is meant by the term “force”?

   ____

   ____

   b. In what unit is force measured? What letter is used for this unit?

   ____

3. A block with a mass of 360 g is hung on a spring.

   a. How big is the force of gravity the Earth exerts on the block? Show your work.

   ____

   ____

   ____

   b. How big is the force the spring exerts on the block? Explain how you know.

   ____

   ____

   ____

   c. If you brought the block and spring to the Moon, would the force be greater, smaller, or the same? Explain.

   ____

   ____

   ____

4. What equipment did you use in the experiment, and how did you use it?

5. A student has collected data for two different springs in an experiment similar to yours.

applied force (N)	0.5	1.0	1.5	2.0	2.5	3.0
extension of spring 1 (cm)	2.0	4.0	6.0	8.0	10.0	12.0
extension of spring 2 (cm)	3.0	6.0	9.0	12.0	15.0	18.0

a. Plot a graph for the extension versus force applied on the graph on the next page for each spring. Clearly label both lines.

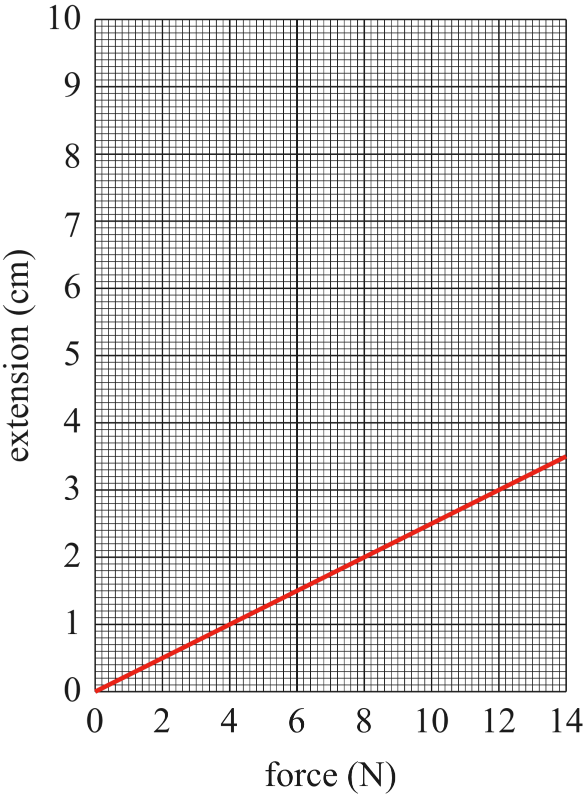
b. Does one of the springs appear to be stretchier than the other one? If so, state which one and why.

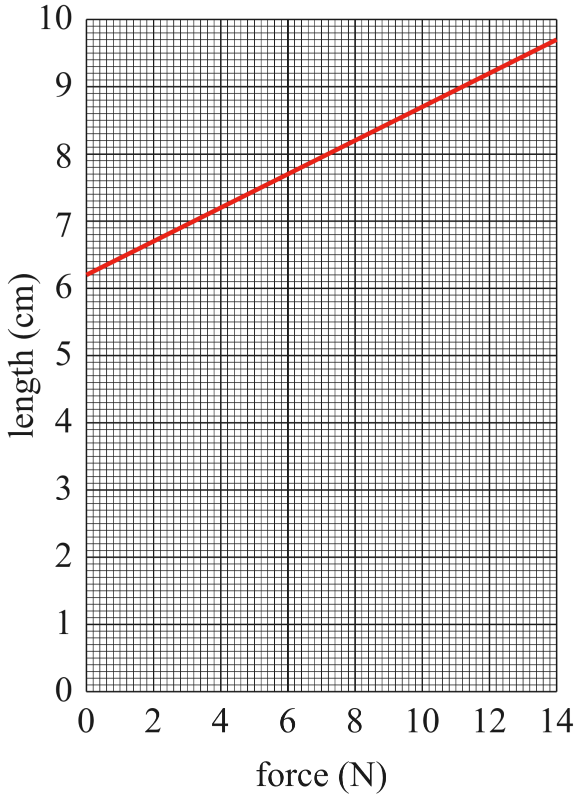
What does the steepness of the line tell you about the spring?

6. **When an object with a mass of 250 g is hung on a spring it extends by 10.0 cm. By how much would the spring extend if you hung an object with a mass of 100 g on it? Show your work.**

Tutorial: Hooke's Law

1. In an experiment like yours a student drew two graphs. On the left graph below the student plotted the **extension** of the spring as disks were added to the mass hanger. On the right graph below the student plotted the **length** of the spring as disks were added to the mass hanger.





a. When there is no force applied, what is the extension of the spring? What is the length?

____

b. Is one of the lines steeper, or are they equally steep?

____

Try to explain why that is so.

____

____

c. What is different about the two lines?

____

____

____

2. What is the extension of the spring when a force of 4 N is applied?

____

What is the extension of the spring when a force of 8 N is applied?

____

What is the extension of the spring when a force of 12 N is applied?

____

3. A student says:

"A spring will have twice the extension if twice the force is applied, 3 times the extension if 3 times the force is applied, and so on…"

Is the student right? Explain how you can tell from the graph.

____

____

____

Is this (nearly) true for the graph you drew in your experiment?

____

____

____

The student's statement is called Hooke's Law.

Hooke's Law applies to many objects, as long as you don't stretch them too much.