

# Chapter 5. Forces and Matter

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- 5.1 Forces acting on solids
- 5.2 Stretching springs: Hooke's law
- 5.3 Pressure

## New word list:

### Core

- 1 Know that forces may produce changes in the size and shape of an object
- 2 Sketch, plot and interpret load-extension graphs for an elastic solid and describe the associated experimental procedures
- 3 Determine the resultant of two or more forces acting along the same straight line

### Supplement

- 9 Define the spring constant as force per unit extension; recall and use the equation  

$$k = \frac{F}{x}$$
- 10 Define and use the term 'limit of proportionality' for a load-extension graph and identify this point on the graph (an understanding of the elastic limit is **not** required)
- 11 Recall and use the equation  $F = ma$  and know that the force and the acceleration are in the same direction

## 1.8 Pressure

### Core

- 1 Define pressure as force per unit area; recall and use the equation

$$P = \frac{F}{A}$$

- 2 Describe how pressure varies with force and area in the context of everyday examples
- 3 Describe, qualitatively, how the pressure beneath the surface of a liquid changes with depth and density of the liquid

### Supplement

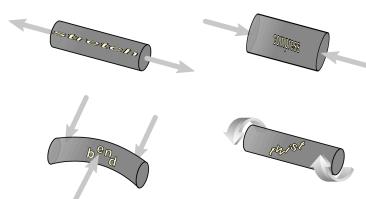
- 4 Recall and use the equation for the change in pressure beneath the surface of a liquid  

$$\Delta P = \rho g \Delta h$$

## 5.1 Forces acting on solids

Forces can change the (       ) and (       ) of an object.

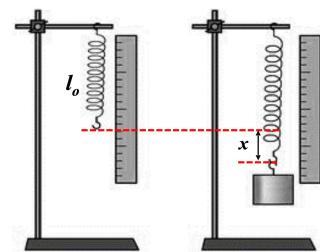
stretched (拉长)	compressed (压缩)	bent (弯折)	twisted (扭转)
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What will the object do when the external forces are removed?

1. Plastic materials (less springy):

2. Elastic materials (springy):



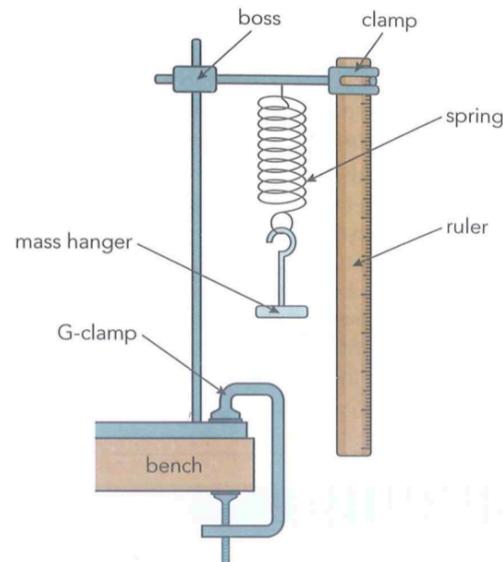
## 5.2 Stretching springs: Hooke's Law

What will the length of spring change if I keep adding loads on the spring?

### Experiment: Investigating springs

- Extension of a spring:
- What is independent(input) and dependent(output) variables?
- Apparatus:
- Recording table:

Load on hanger / N	Ruler reading / cm	Spring extension / cm	Does the spring return to original length when unloaded? Y/N



- How to plot the graph?

At least 6 sets of readings

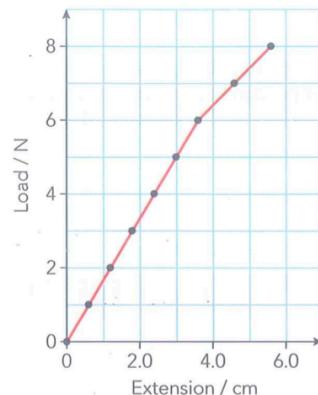
Draw axes and choose suitable scales

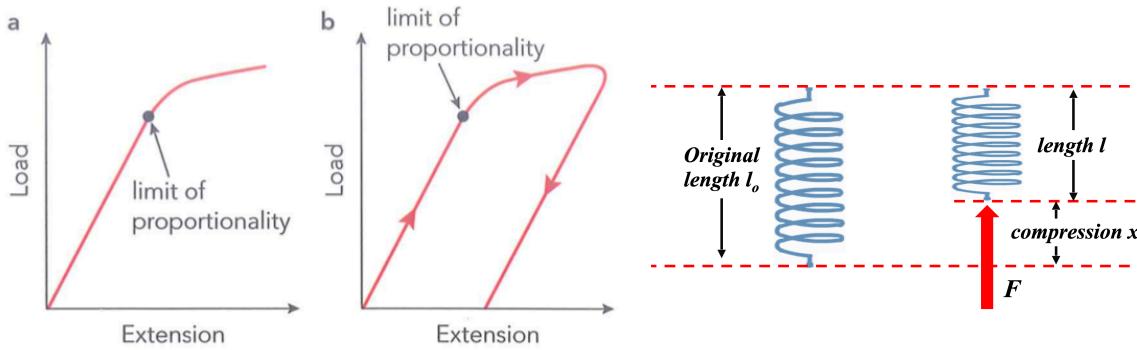
Plot points shown as crosses

Draw a best-fit line

(The points should be scattered equally about the line)

Find the intercept and gradient of the graph





**Limit of proportionality:**

Within the limit of proportionality: **Hooke's Law:**

**k:**

### Exercise 5.a

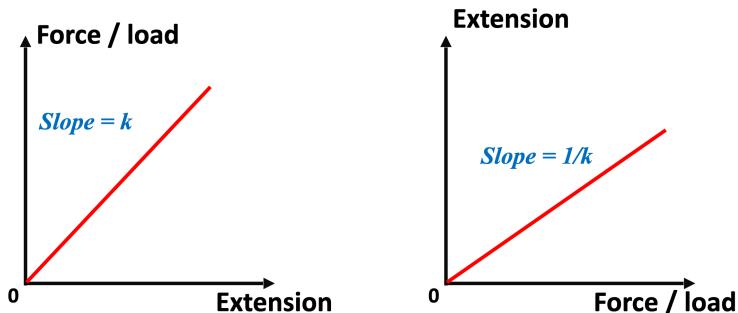
A spring with a natural height of 57 mm is compressed by a 300 g mass to a new height of 51 mm. ( $g=10 \text{ m/s}^2$ )

(a) Find the spring constant.

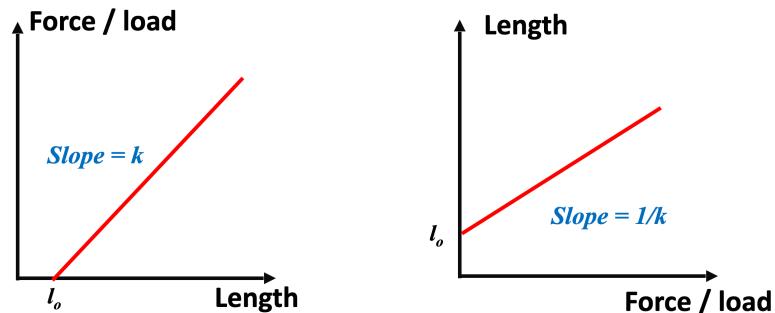
(b) Find the length of the spring if the 300 g mass were replaced by a 400 g mass.

Other graphs:

Load-extension:



Load-length:



## 5.3 Pressure

Definition of **pressure**:

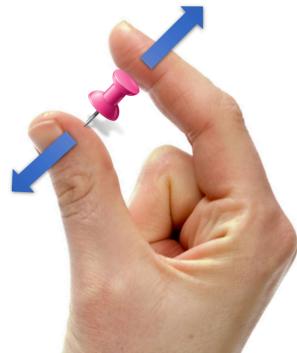
★Equation:

Unit:

Factors that affect the pressure acting on a surface:

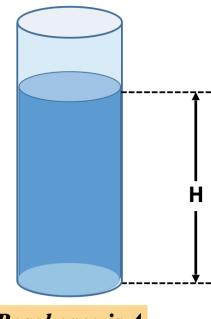
**directly proportional vs  
inversely proportional**

Which of the situations in everyday life are the applications of **high pressure**? Which are applications of **low pressure**?



### 5.3.1 Pressure in the liquid

Where does pressure in liquid come from? Calculate the pressure exerted by water to the bottom



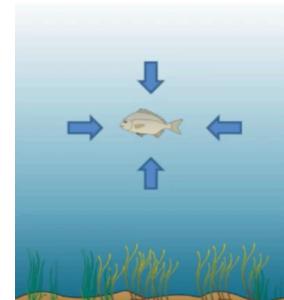
★Pressure in liquid:

Change in pressure:

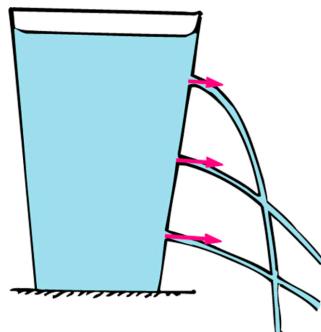
1. Pressure in liquid doesn't depend on the shape of the container.



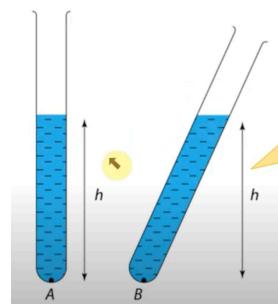
2. Pressure at any same-depth point in liquid acts equally in all directions.



3. The pressure in liquid increases with depth.



4. The pressure depends on the vertical depth of the liquid.



### Liquid pressure summary

#### **Pressure increases with depth**

Pressure depends on the density of liquid

Pressure doesn't depend on the shape of the container

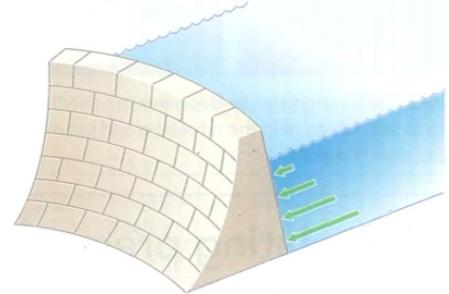
Pressure acts in all directions

Pressure at a given depth is the same in all directions

#### Exercise 5.c

Explain the following situations

- Why submarine needs to be made by extra tough materials?
- Why the dam is thickest near its base?



#### **5.3.2. Pressure in the air:**

Where do you think atmospheric pressure comes from? How can you prove it exist?

The atmospheric pressure changes accordingly to the **altitude**. Altitude is the height above the (              ).

The greater the altitude, the (              ) the atmospheric pressure.

The atmospheric pressure acts on every object in the atmosphere. It acts (              ) in (              ) directions.

#### Exercise 5.d

Calculate the pressure on the bottom of a swimming pool that is 2.5 meters deep. What is the total pressure on the bottom?