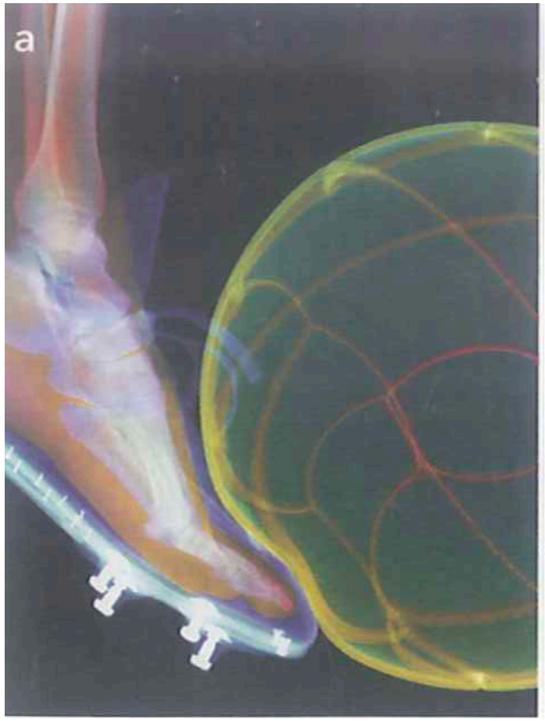
Chapter 5.
Forces and Matter

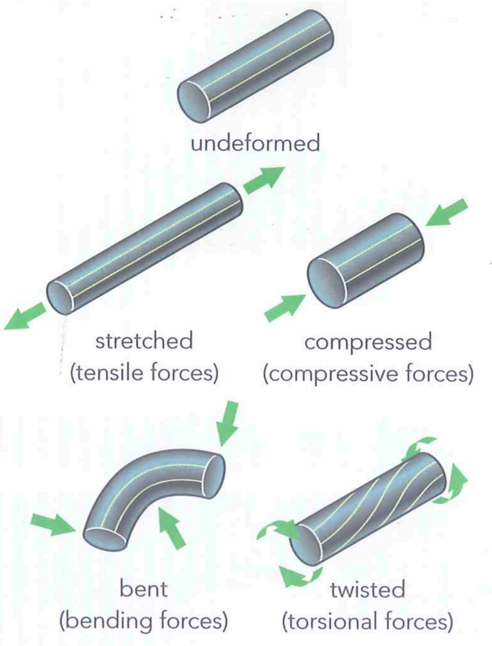
New Words

load, extension, compression, spring constant, limit of proportionality, springy, plastic, elastic, deform, upthrust, withstand, stretch

Forces Acting on Solids

We already know force can make object **change velocity** and **rotate**, what else can force do?





Forces can change the ***size*** and ***shape*** of an object.

Materials

What will the object do when the external forces are removed?

Plastic materials: will ***not*** return to original size & shape

Elastic materials: will return to original size & shape

Stretching Springs

What will the length of spri ne spring?

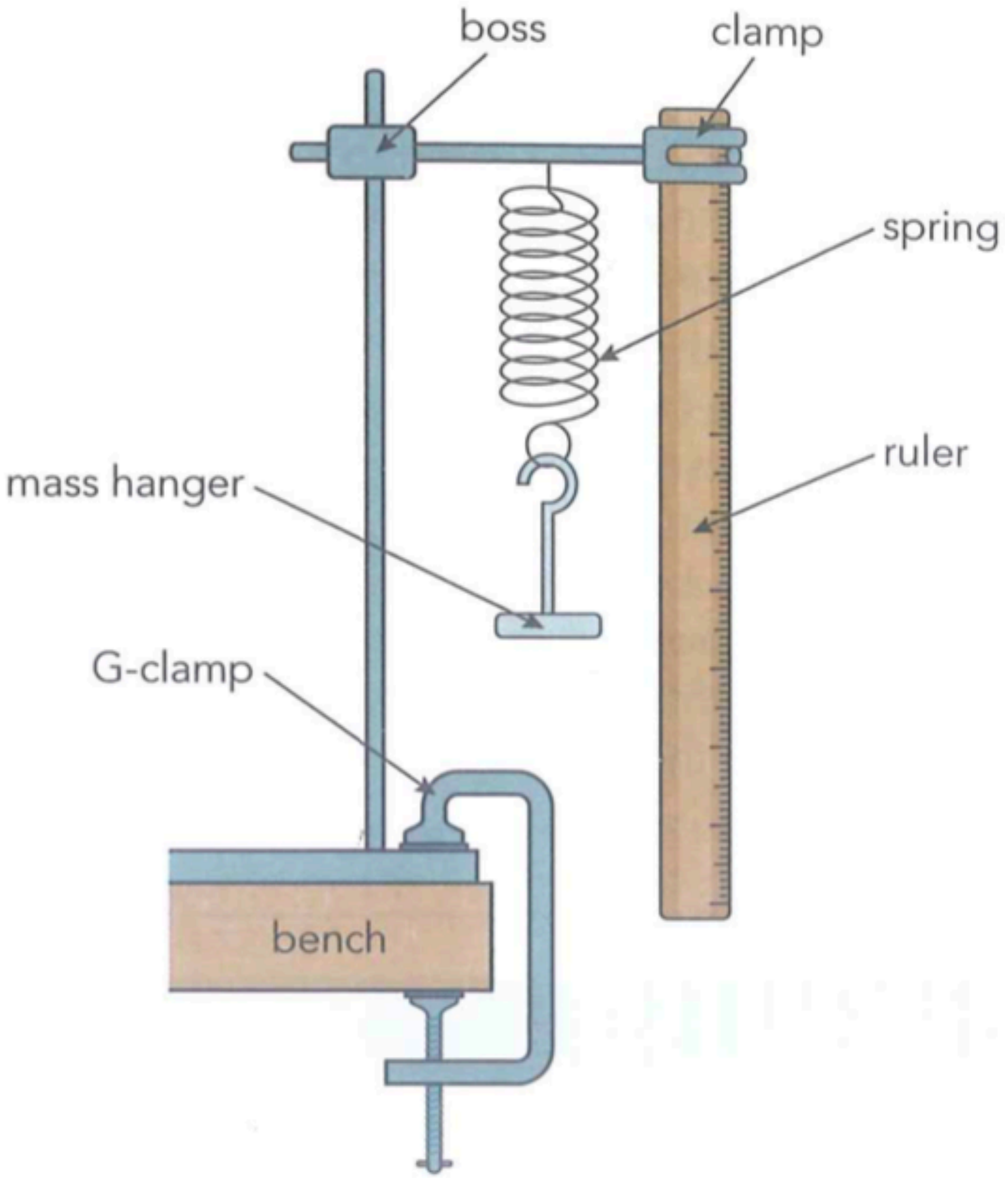
Experiment: Investigatin

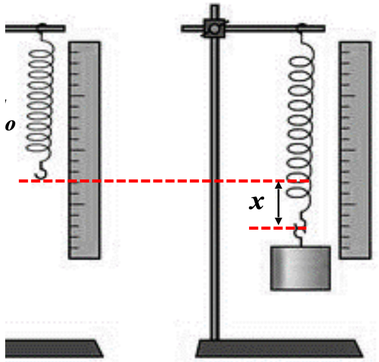
Extension: Measurec

independent vs depe

loa

Apparatus:





Stretching Springs

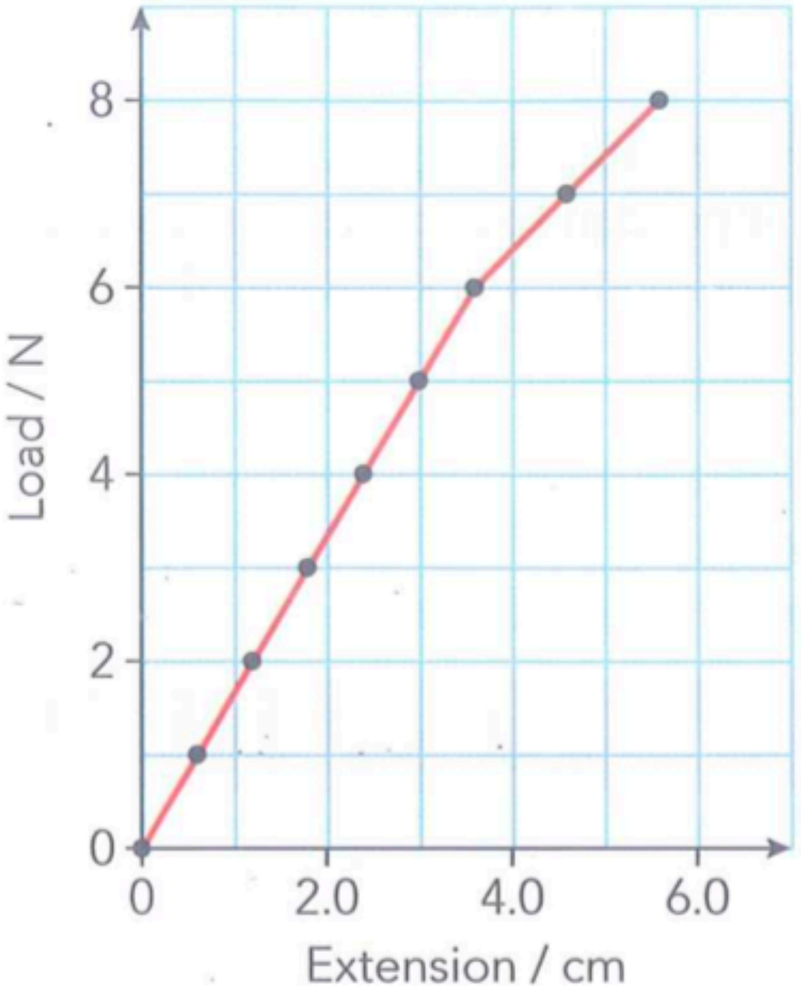
Experiment: Investigating springs

Recoding table:

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

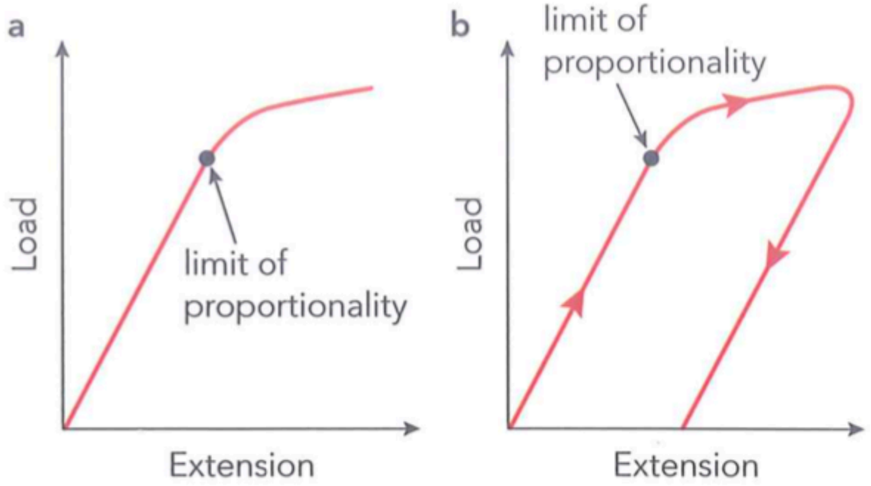
•How to plot the graph?

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



Hooke's Law

★**Limit of proportionality:** Up to this limit, the extension on spring is ***proportional*** to its load.



Within the limit of proportionality, spring obeys:

★**Hooke's Law:** The extension is proportional to the load applies to it.

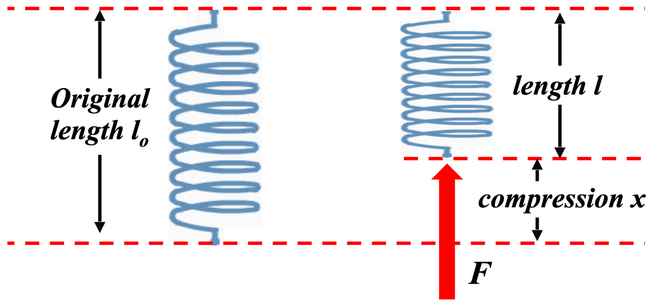
$$F = kx$$

F: load
易错点：当挂的是重物时，load (F)是它的weight， 不是mass。$F = W = mg$

k: spring constant (A measurement of ***stiffness*** of a spring)

x: **extension** (measured length - original length)/ **compression**(original length - measured length)

Unit: N/m; N/cm

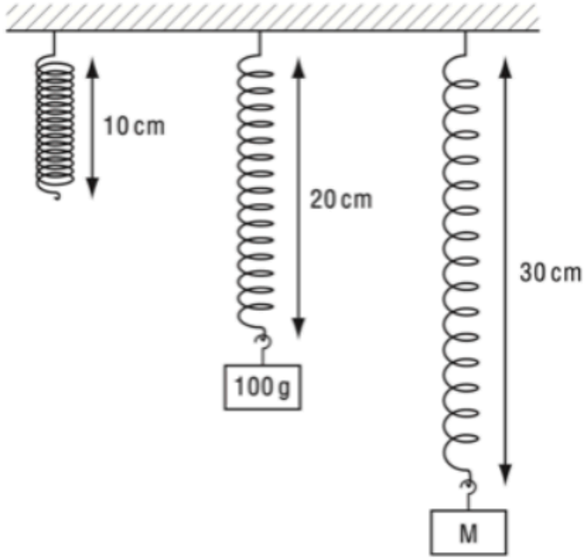


Exercise

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 m/s2)
(a) Find the spring constant.
(b) Find the length of the spring if the 300 g mass were replaced by a 400 g mass.

Exercise

26 Objects with different masses are hung on a spring. The diagram shows how much the spring stretches.

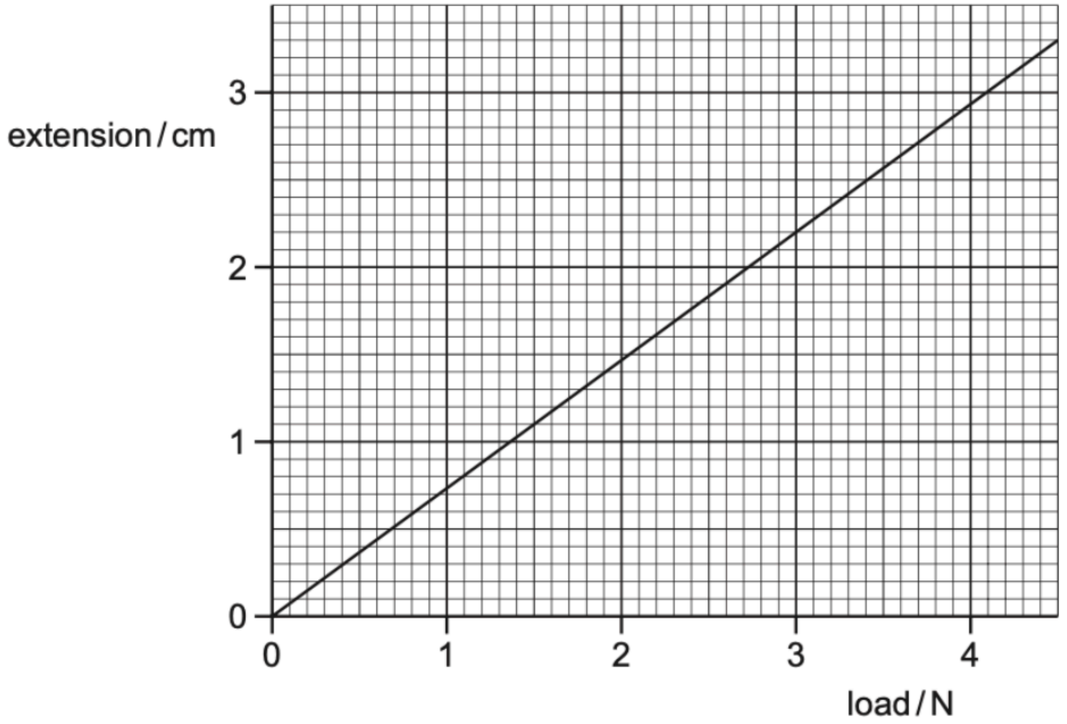


The extension of the spring is directly proportional to the mass hung on it. What is the mass of object M?

A 110g **B** 150g **C** 200g **D** 300g

Exercise

The extension–load graph for a spring is shown. The unstretched length of the spring is 17.0 cm.



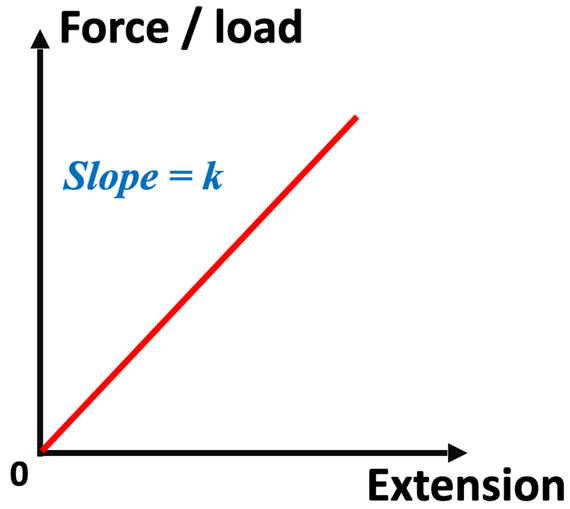
When an object is suspended from the spring, the length of the spring is 19.2 cm.

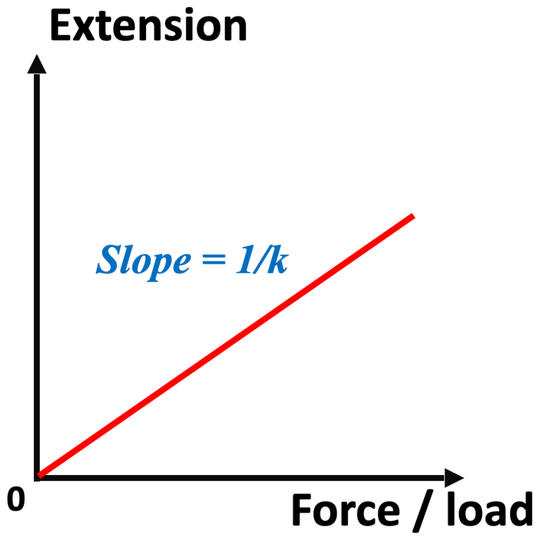
What is the weight of the object?

A 1.4 N **B** 1.6 N **C** 2.6 N **D** 3.0 N

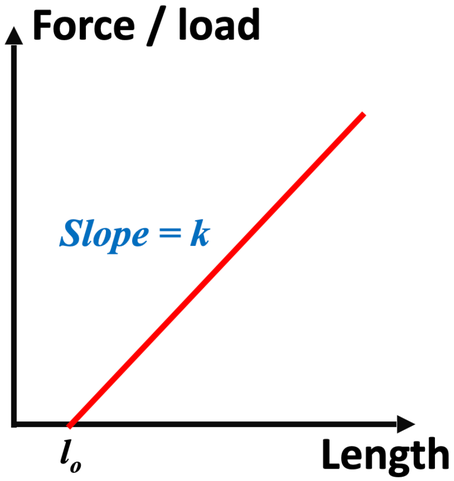
Other graphs:

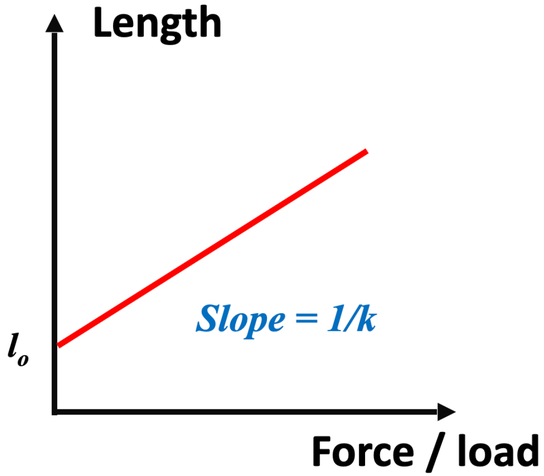
Load-extension:





Load-length:





Pressure

pressure: perpendicular force acting on a surface per unit area

★**Equation:** $p = \frac{F}{A}$

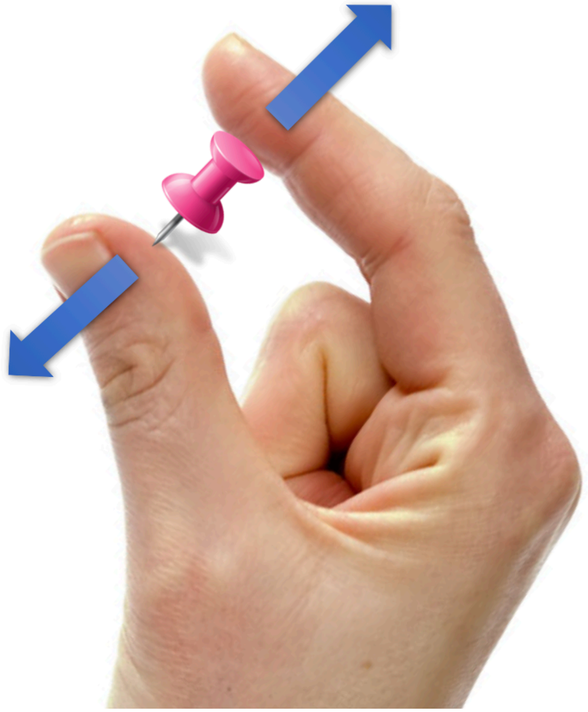
Unit: $1\ Pa = 1\ N/m^2$

pressure is a **scalar**

Pressure depends on:	Force (F)	p directly proportional to F
	Area (A)	p inversely proportional to A

Pressure

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



Pressure

Pressure

Exercise

28 Pressure is related to the force and area.

Which situation cannot be explained using this relationship?

A Using a longer spanner than normal to undo a tight nut.

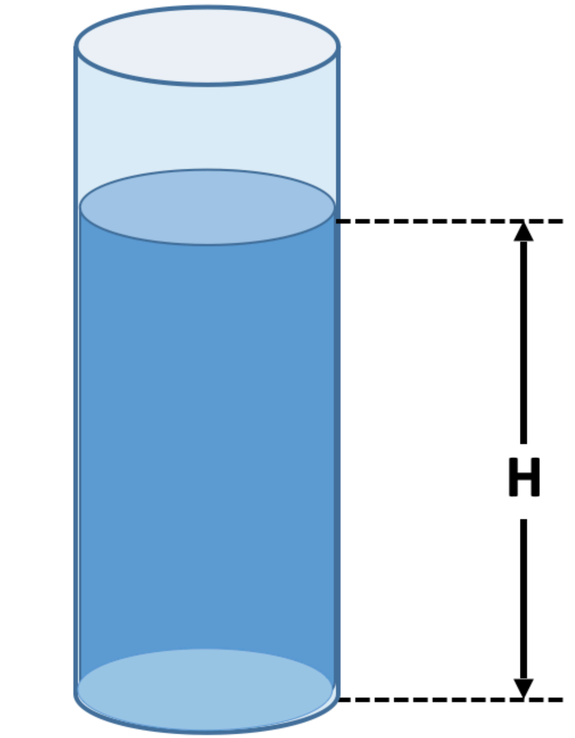
B Hammering a nail into a piece of wood

C Tractors using wide tyres in a muddy field

D A sharp kitchen knife cutting vegetables more easily than a blunt one

Liquid Pressure

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

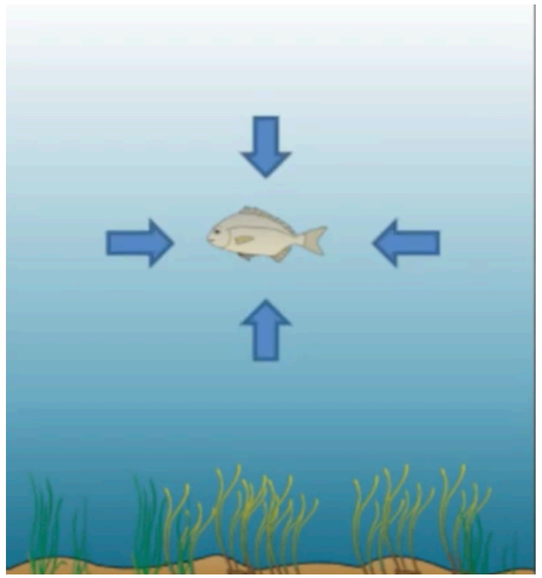


Liquid Pressure

★**Pressure in liquid:** $p = \rho g h$

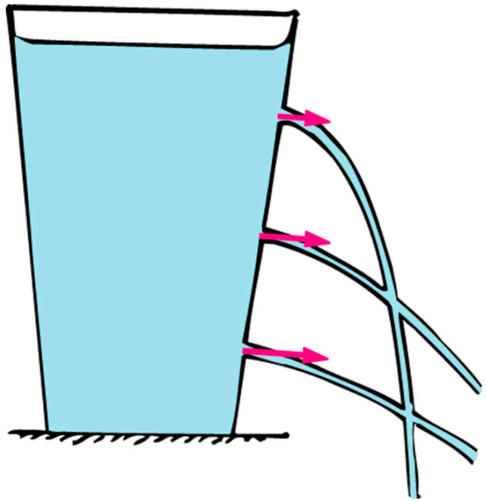
Change in pressure: $\Delta p = \rho g \Delta h$

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

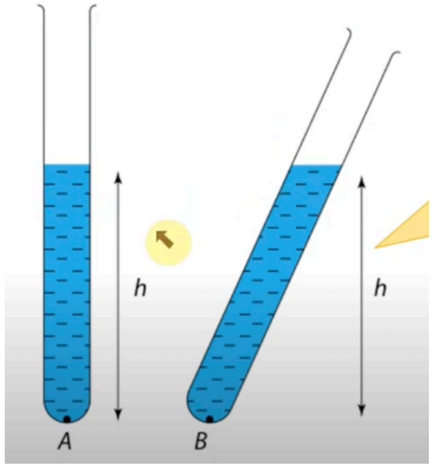


2. Pressure at any same-depth point in liquid acts equally in all directions.

Liquid Pressure



★3. The pressure in liquid **increases** with



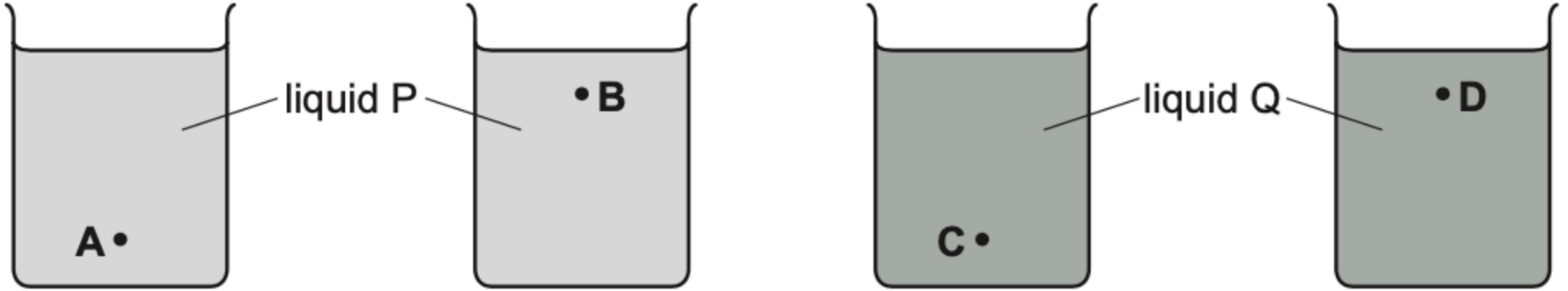
4. The pressure depends on the vertical depth of the liquid.

Liquid Pressure Summary

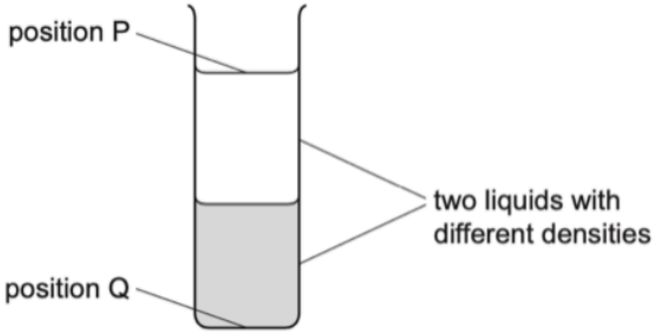
- ***Pressure increases with depth***
- Pressure depends on the density of liquid
- Pressure doesn’t depend on the shape of the container
- Pressure acts in all directions
- Pressure at a given depth is the same in all directions

Four identical beakers are filled with equal volumes of liquids P or Q, as shown. Liquid P is more dense than liquid Q.

At which point is the pressure the least?

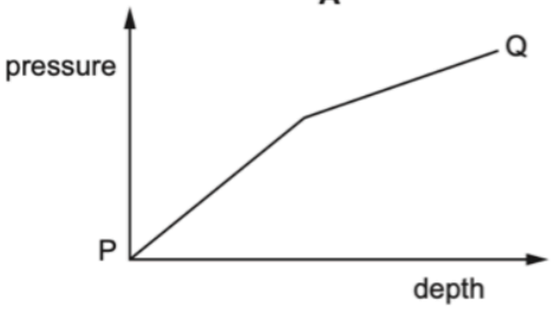


30 A tall cylinder is partly filled with two liquids which do not mix. The two liquids have different densities. A student measures the pressure due to the liquids at different depths.

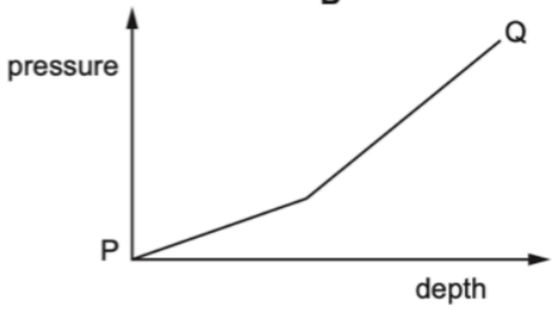


Which graph shows how the liquid pressure varies between positions P and Q?

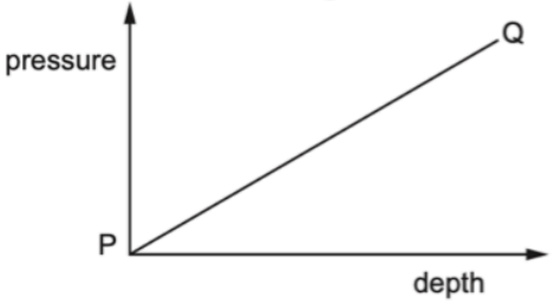
A



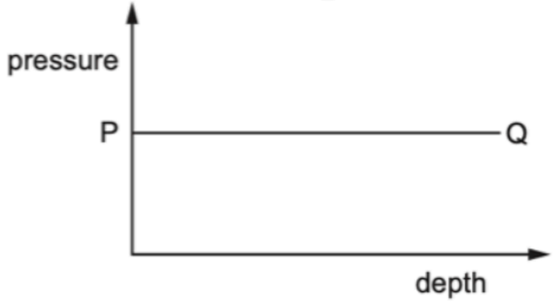
B



C



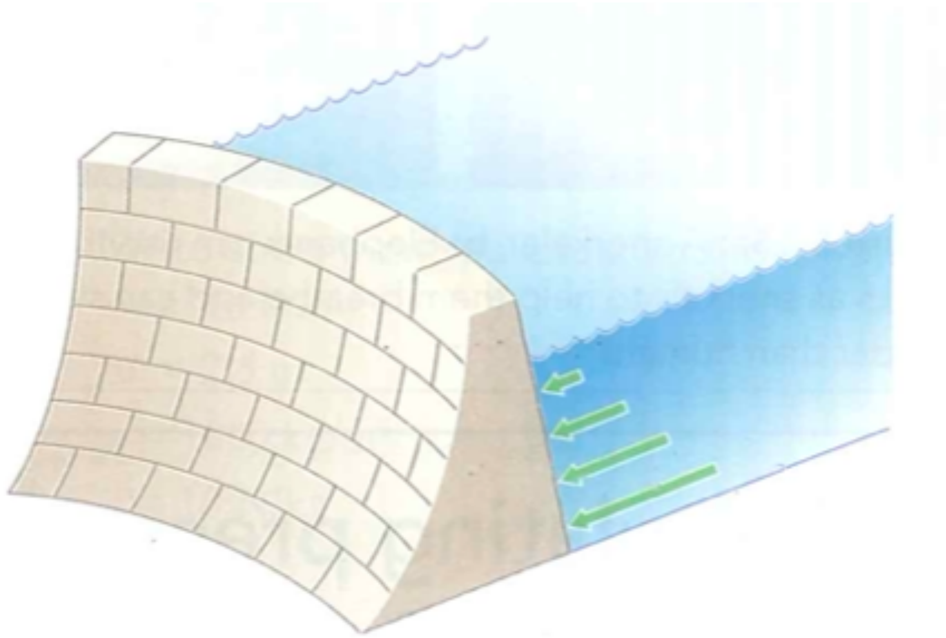
D



Exercise

Explain the following situations

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



Air Pressure

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 **sea level**.
The greater the altitude, the **smaller** the atmospheric pressure.
The atmospheric pressure acts on every object in the atmosphere. It acts **equally** in **all** directions.

Exercise

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