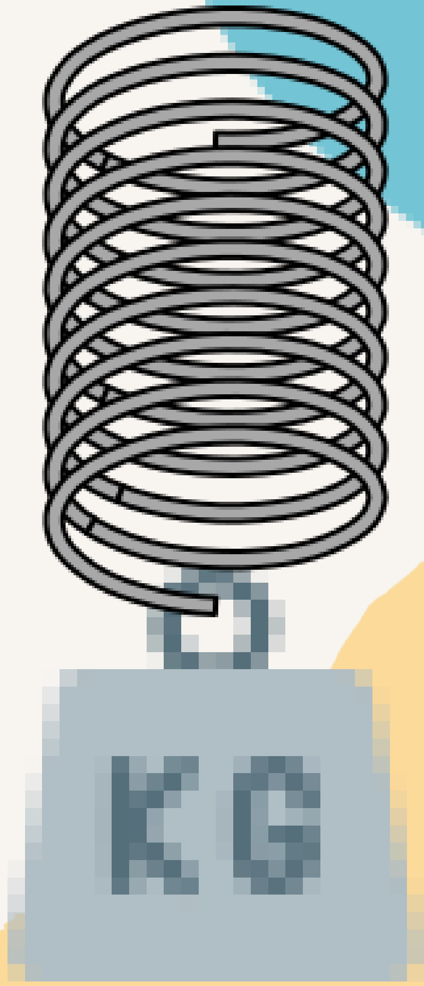
EXAM PAPERS PRACTICE

FORCES AND MATTER

CIE IGCSE PHYSICS for board 0625 and 0972

(For exams 2025+)



LESSON OVERVIEW

5.1	5.2	5.3	5.4
Forces acting on solids	Stretched springs	The limit of proportionality and spring constant, Hookes Law	Pressure

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WHY LEARN ABOUT THIS CHAPTER?

Understanding how force affects matter help engineer to understand the behaviour of each material under stress and strain. This allows engineers to determine the appropriate materials and dimensions required for a given application.

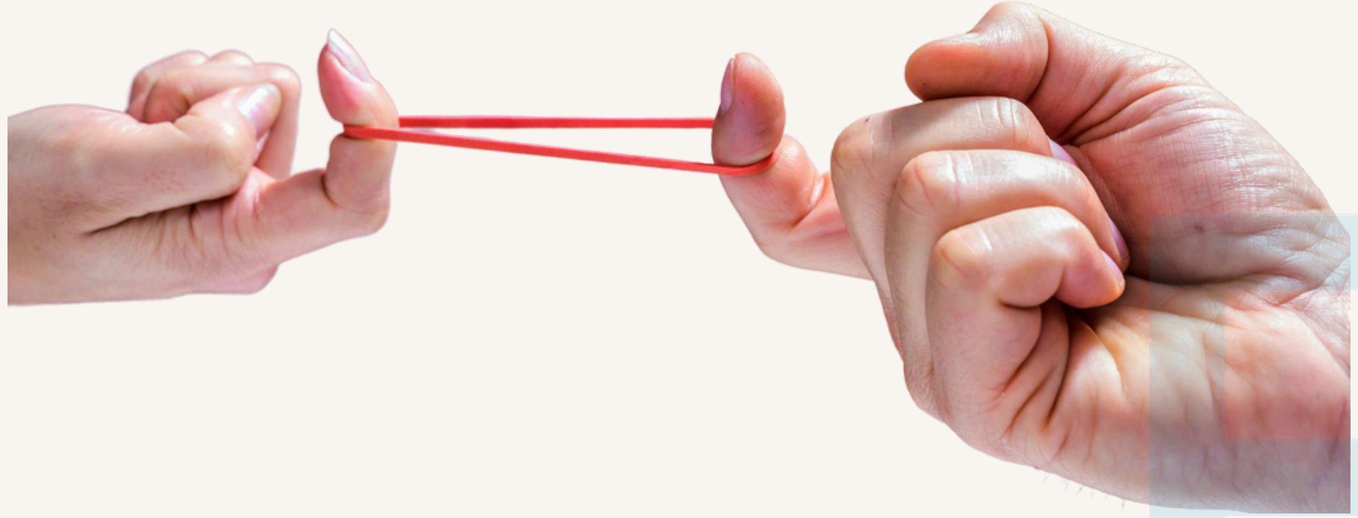
FORCES ACTING ON SOLIDS

EXAM PAPERS PRACTICE

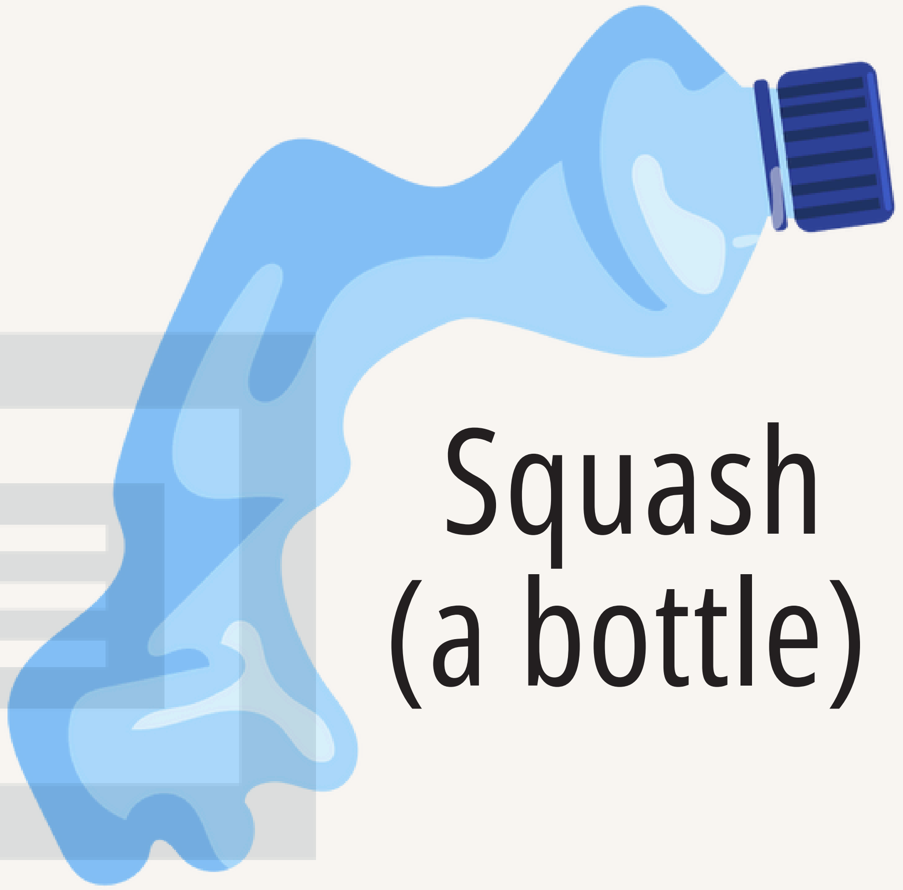
Forces can change the sizeand shapeof an object.

FORCES ACTING ON SOLIDS

For example:



Stretch



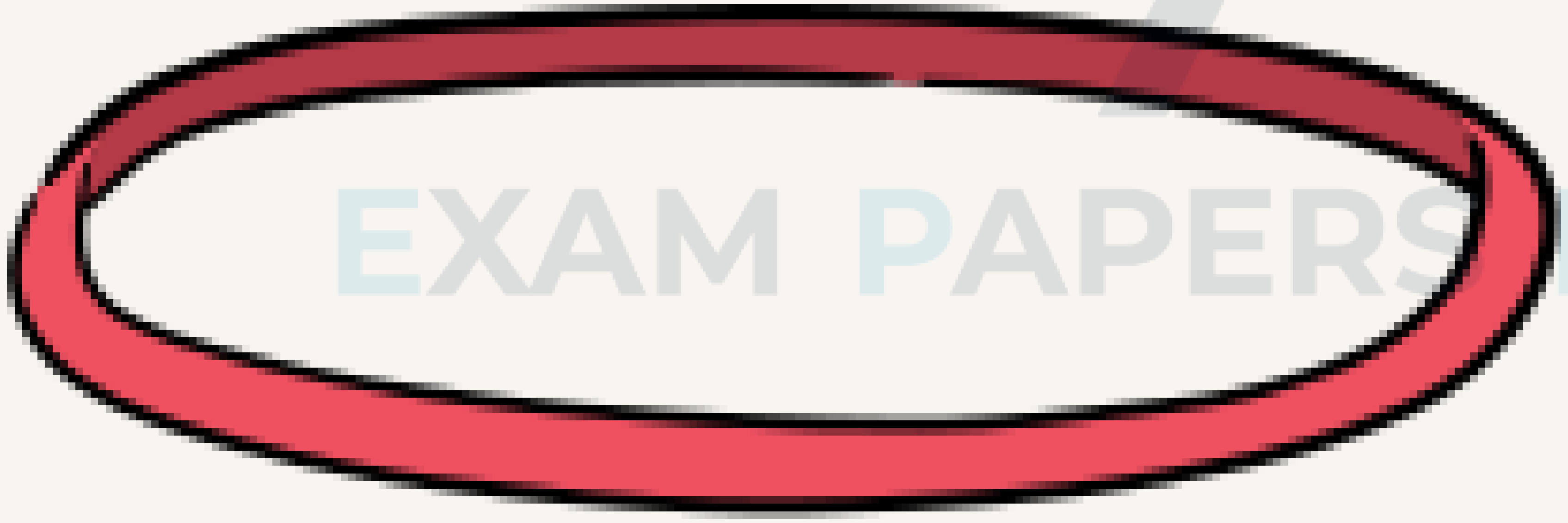
Squash (a bottle)

Bend

Twist

FORCES ACTING ON SOLIDS

Certain materials, like foam rubber, regain their original shape after external forces are removed, whereas others, such as metals like gold, remain permanently deformed under the influence of forces.



LESSON OVERVIEW

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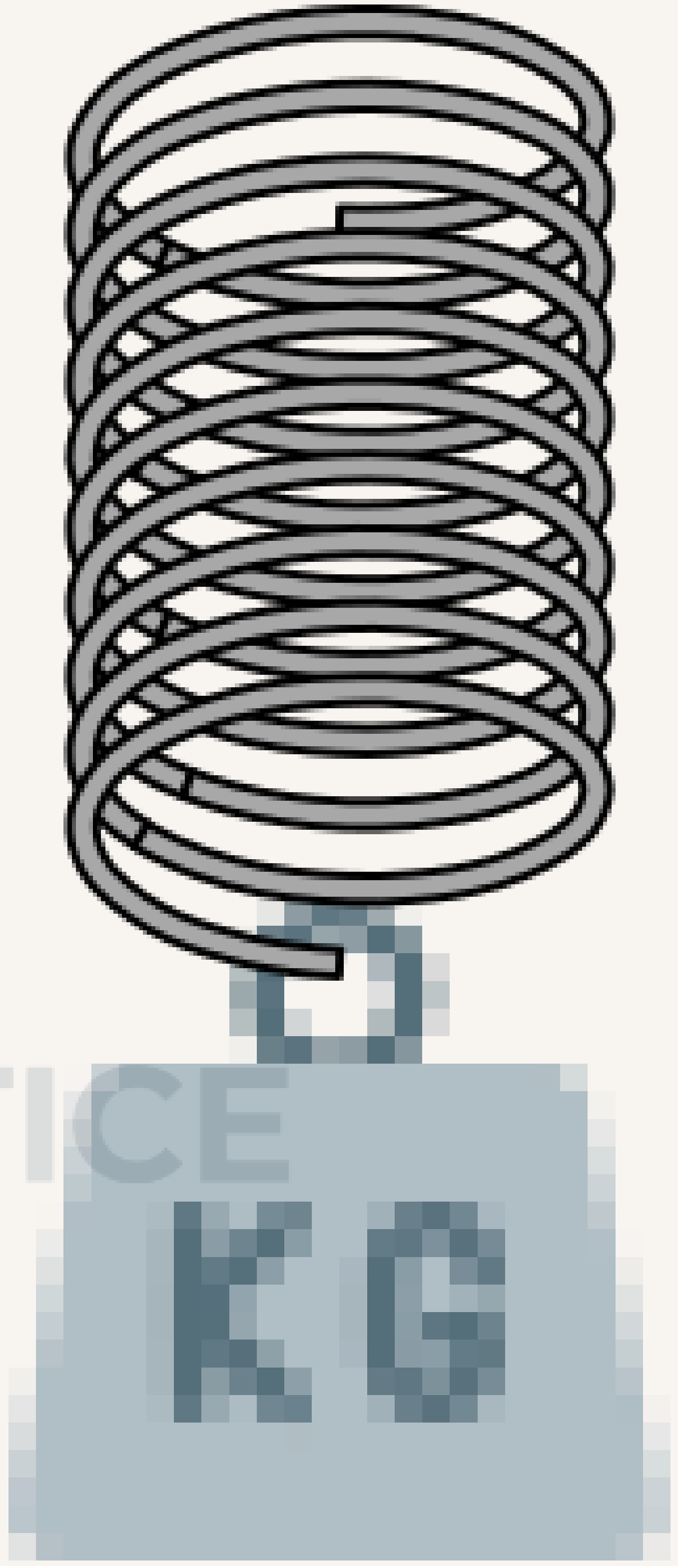
STRETCHED SPRING

Springs are engineered to elongate significantly with minimal applied force, facilitating precise measurement of their length change.



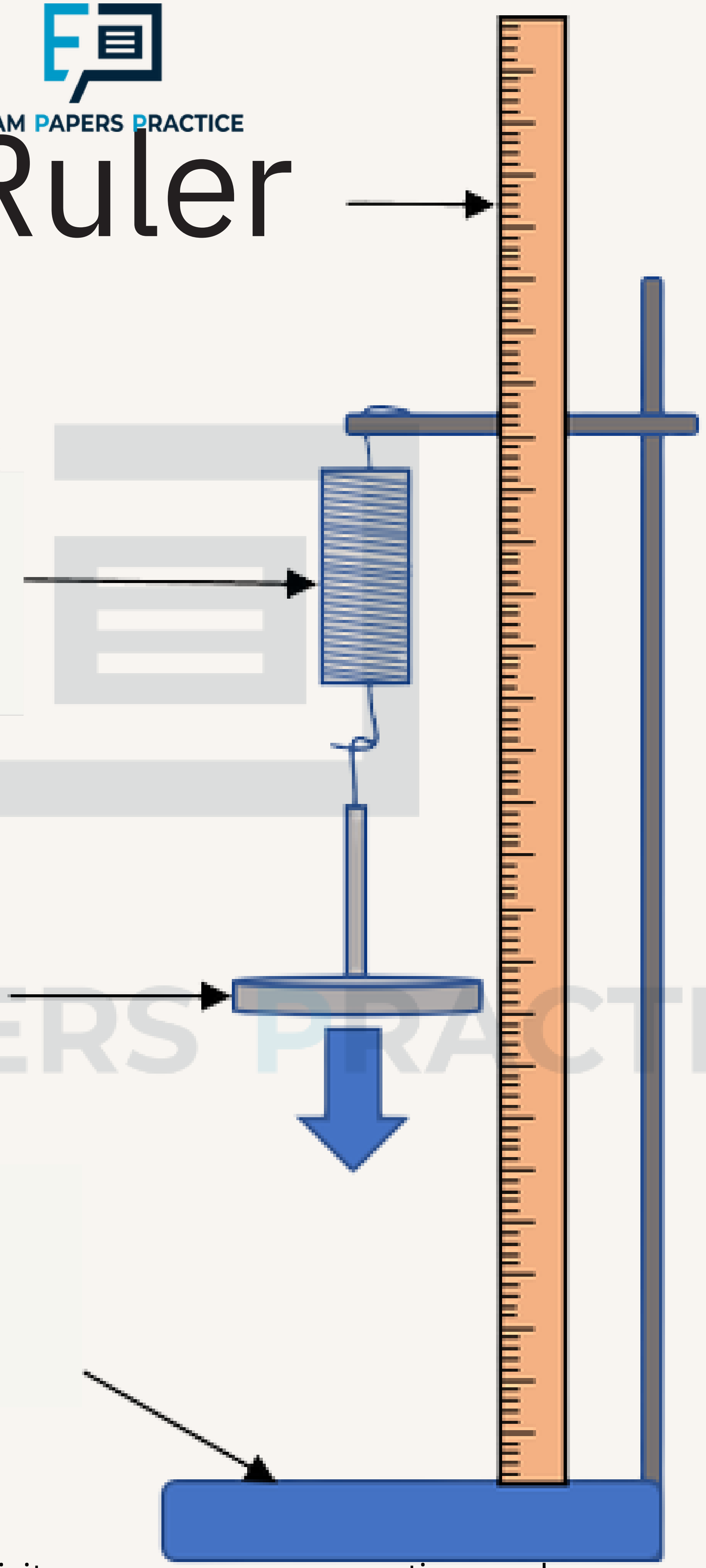
KEY TERMS

Ruler

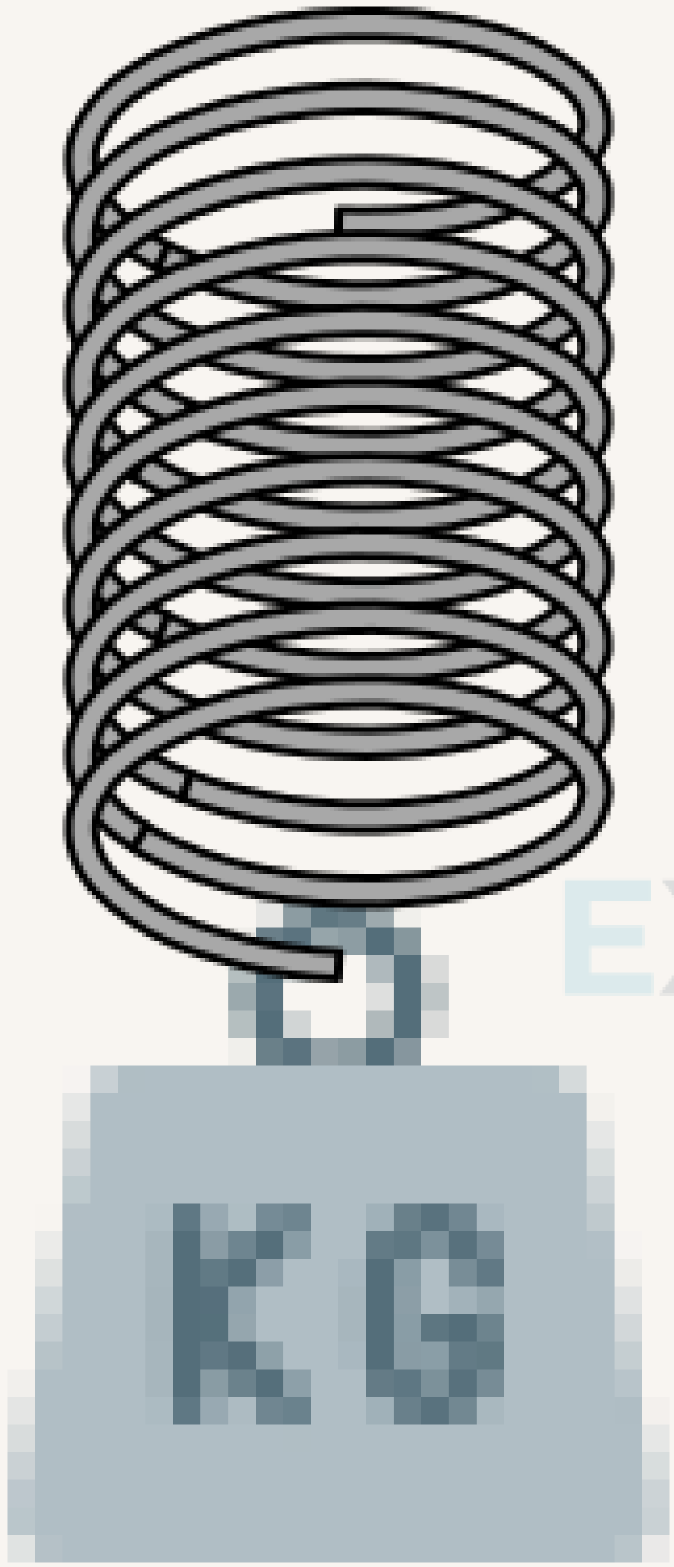
Sprin

Weight/loa g

clamp



KEY TERMS



Load ⭐	The force (usually weight) stretches an object (of a spring)
Extension ⭐	The increasedlength of an object (for example, a spring) when a load (for example, weight) is attached to it

WORKED EXAMPLE

Load / N	Length / cm	Extension / cm
0.0	10.0	
1.0	13.0	
2.0	16.0	
3.0	19.0	
4.0	25.0	
5.0	31.0	
6.0	37.0	

The table provided below demonstrates how to utilize a three-column format for recording the outcomes of a spring stretching experiment.

WORKED EXAMPLE

Load / N	Length / cm	Extension / cm
0.0	10.0	0.0
1.0	13.0	3.0
2.0	16.0	6.0
3.0	19.0	9.0
4.0	25.0	15.0
5.0	31.0	21.0
6.0	37.0	27.0

1. Populate the extension column.

WORKED EXAMPLE

Load / N	Length / cm	Extension / cm
0.0	10.0	0.0
1.0	13.0	3.0
2.0	16.0	6.0
3.0	19.0	9.0
4.0	25.0	15.0
5.0	31.0	21.0
6.0	37.0	27.0

2. When the load is increasing from 0N to 4N, how does the extension of the spring change?

ANSWER

When the load is increased by 1N, the extension of the spring increased by 3 cm.
Doubling the load doubles the extension.

WORKED EXAMPLE

Load / N	Length / cm	Extension / cm
0.0	10.0	0.0
1.0	13.0	3.0
2.0	16.0	6.0
3.0	19.0	9.0
4.0	25.0	15.0
5.0	31.0	21.0
6.0	37.0	27.0

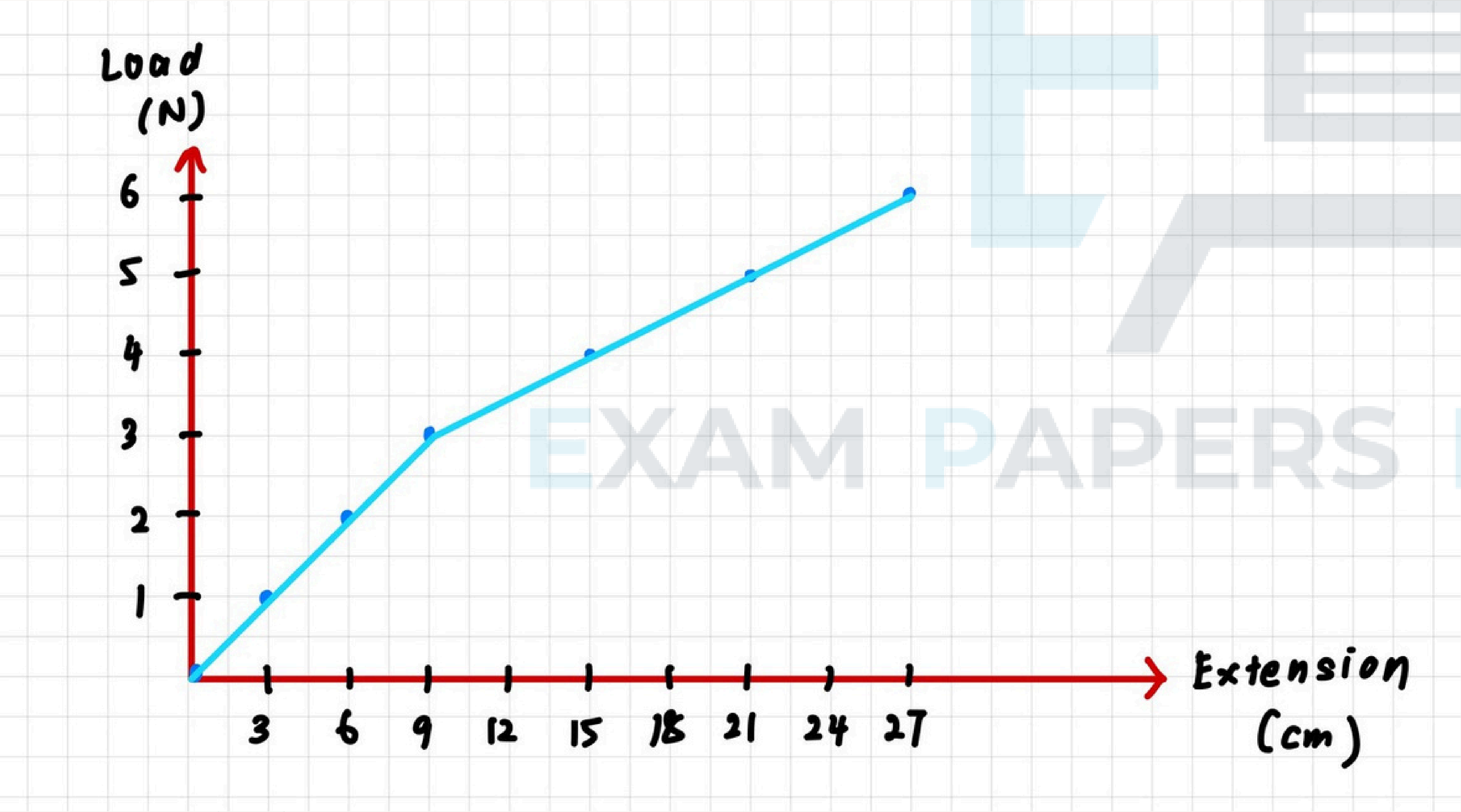
3. Do you observe the same pattern when the load is increased to 4N/5N/6N. Why is that so?

ANSWER

No, the spring now extend even more when the load exceeds 3N. This happens when the load is so great that the spring has become permanently damaged. It will not return to its original shape.

WORKED EXAMPLE

4. Draw a load-extension graph to see how extension depends on the load.



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5.0 6.0	31.0	21.0 27.0
	37.0	

LESSON OVERVIEW

5.1

Forces acting on solids

5.2

Stretched springs

5.3

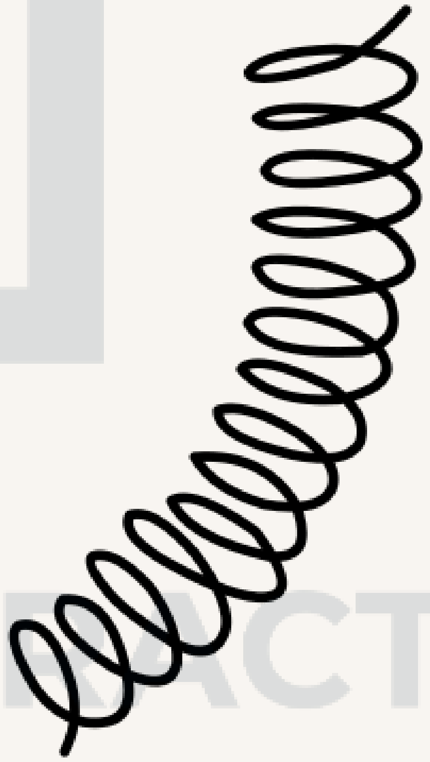
The limit of proportionality and spring constant, Hookes Law

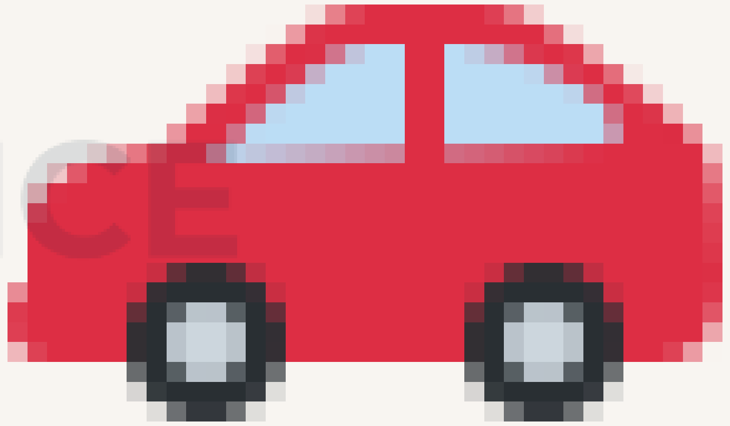
5.4

Pressure

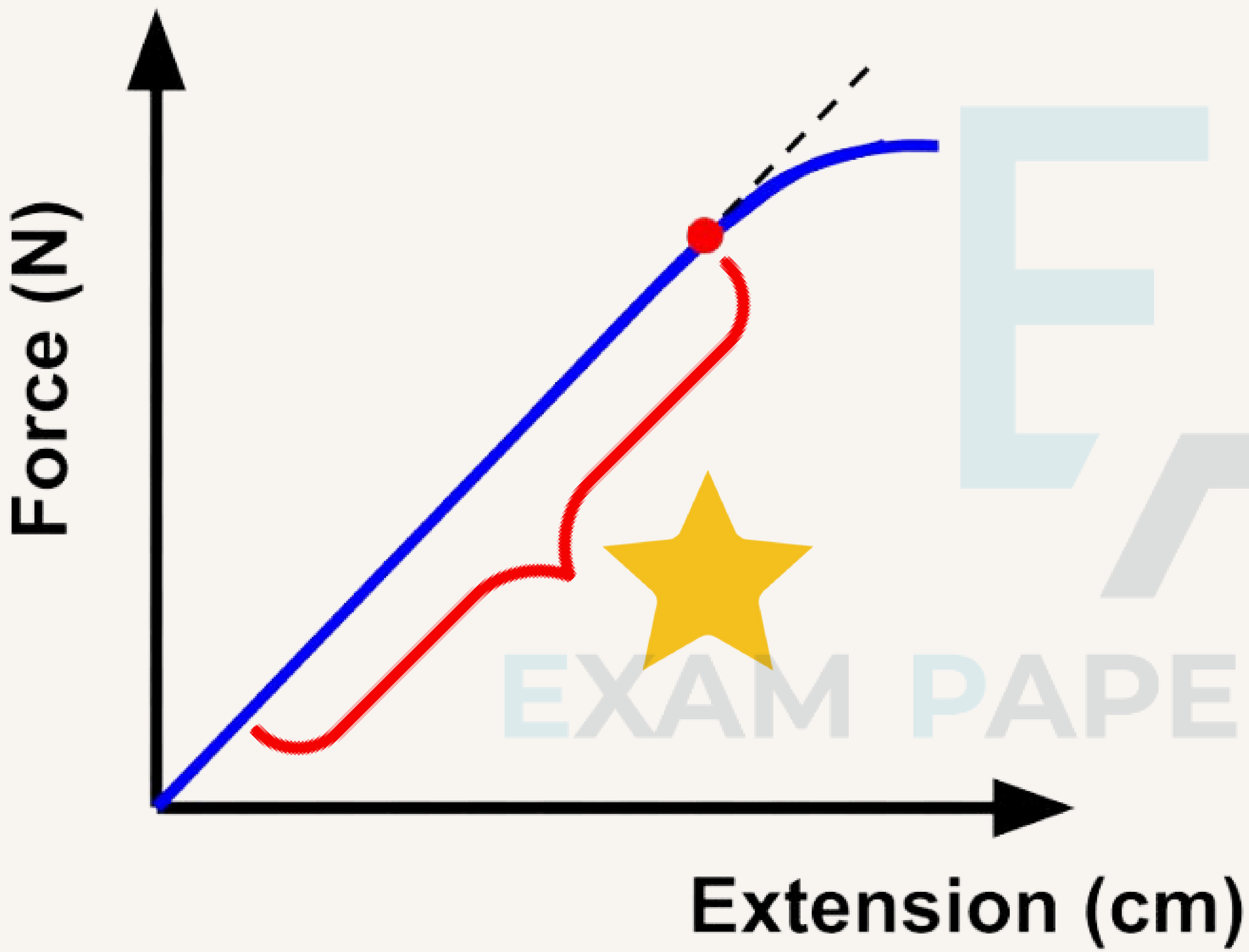
WHY LEARN ABOUT SPRING?

Springs are widely used in numerous devices and systems, including automotive suspensions, mattress coils, door hinges, and many more.
By comprehending Hooke's Law, students can understand how springs store and release energy, enabling them to work effectively in various applications.





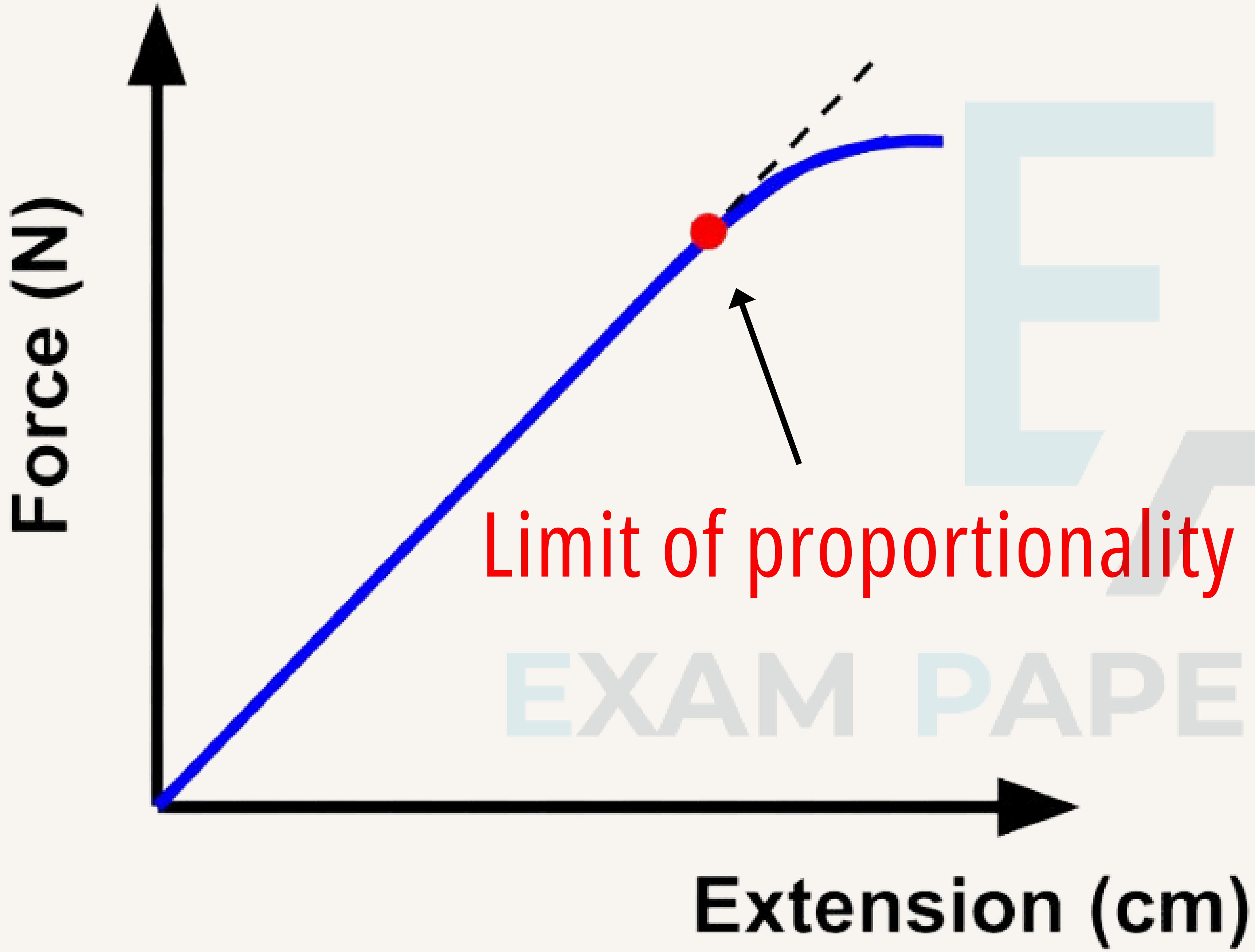
THE LIMIT OF PROPORTIONALITY AND SPRING CONSTANT



Analysis from the graph:

1. Initially, the graph forms a straight line rising from the origin, indicating that the extension is directly proportionalto the load.

THE LIMIT OF PROPORTIONALITY AND SPRING CONSTANT



Analysis from the graph:

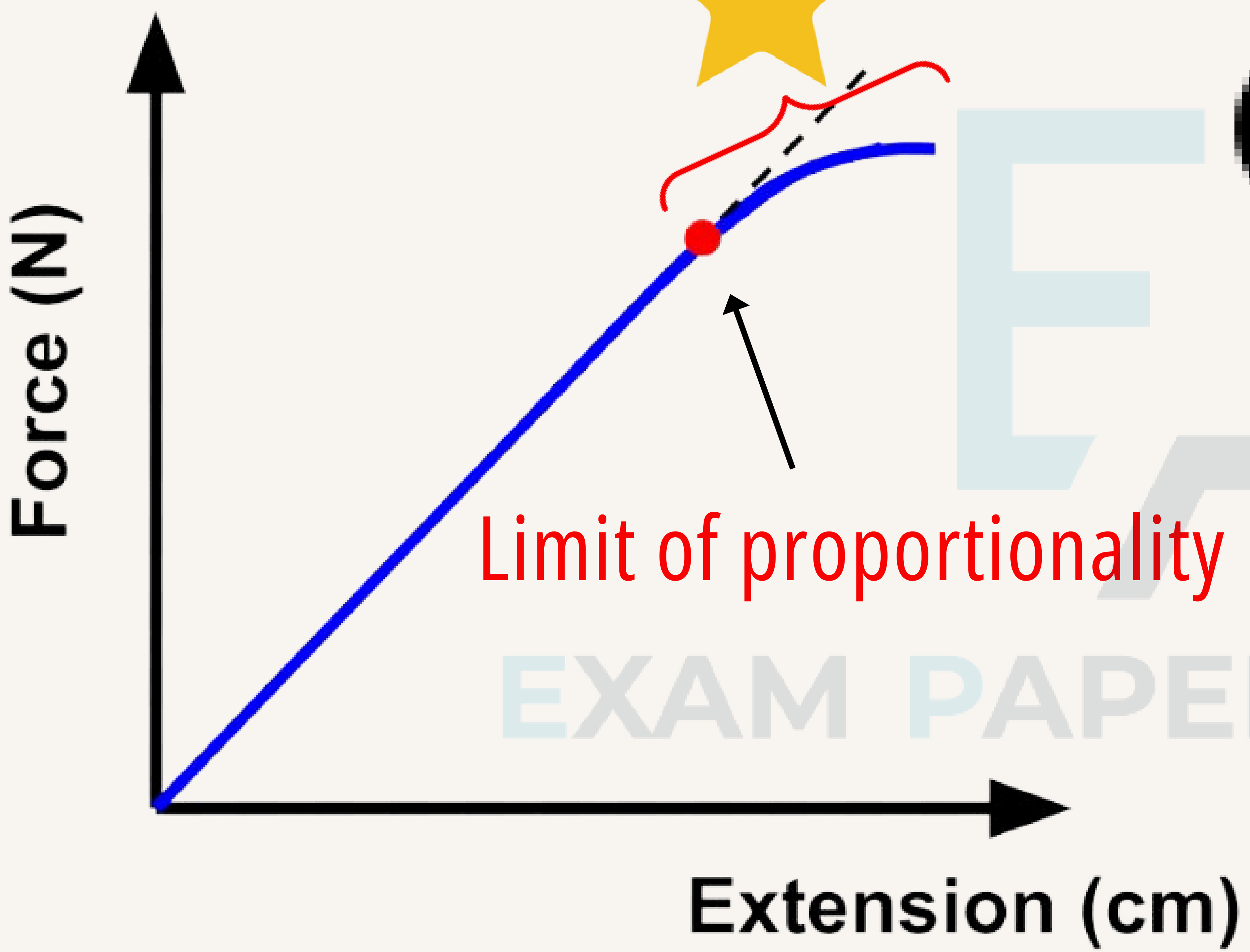
2. At a specific point, the graph begins to curve and the slope of the line decreases. This point is known as the limit of proportionality.

NOTE ON LIMIT OF PROPORTIONALITY:

UP TO THIS LIMIT, THE EXTENSION ON A SPRING IS PROPORTIONAL TO LOAD.

THE LIMIT OF PROPORTIONALITY AND SPRING CONSTANT

EXAM PAPERS PRACTICE



Analysis from the graph:

3 Beyond the limit of proportionality, the extension is no longer directly proportional to the load, and the material experiences permanent

HOOKE'S LAW

ROBERT HOOKE

"Hooke's Law states that the force exerted by a spring is directly proportional to the extension or compression of the spring from its equilibrium position."

HOOKE'S LAW

ROBERT HOOKE

Equation

F = kx

F = force, k = spring constant, x = extension

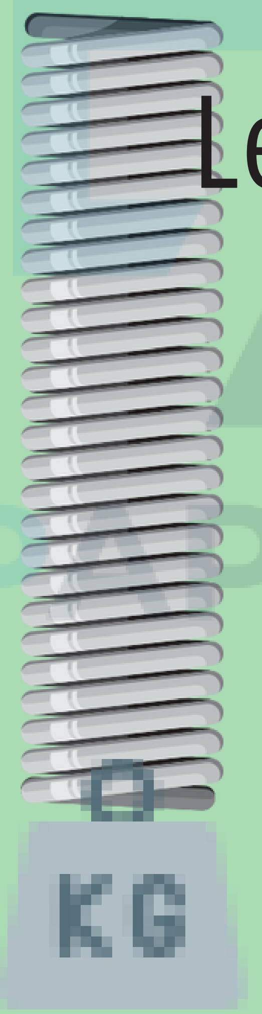
SPRING CONSTANT = Stiffness of a spring

Can be calculated using:

$$K = F / x$$

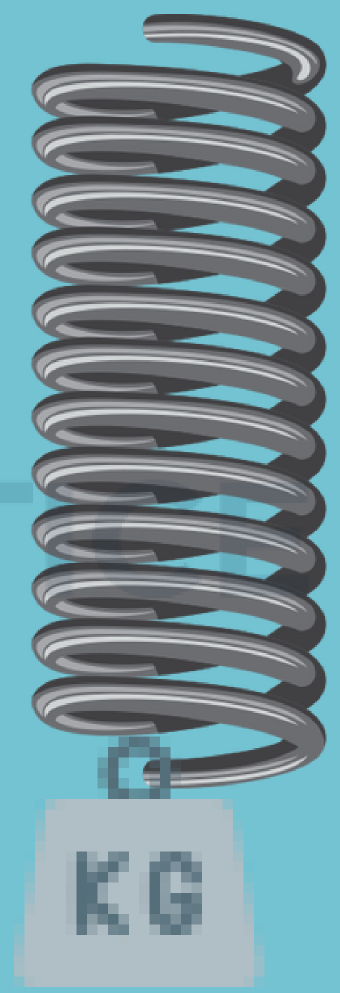
The higher the spring constant of a spring, the harder it is to extend the spring.

High Spring Constant



Less extension per unit force

Low Spring Constant



More extension per unit force

WORKED EXAMPLE

A cable has a spring constant, k, of 15 N/m. What weight is required to cause a stretch of 1.8 m?

WORKED EXAMPLE

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$F = kx$

$= 15(1.8)$

$= 27n$

WORKED EXAMPLE

A rubber band needs a force of 10 N to stretch it by 8.0 cm. What force will extend it by 15 cm?

WORKED EXAMPLE

A rubber band needs a force of 10 N to stretch it by 8.0 cm. What force will extend it by 15 cm?

a. Calculate spring constant

$10 = k\,(8.0)$

$k = 1.25$

b. $F = kx$

$= 1.25\,(15)$

$= 22.5\text{N}$

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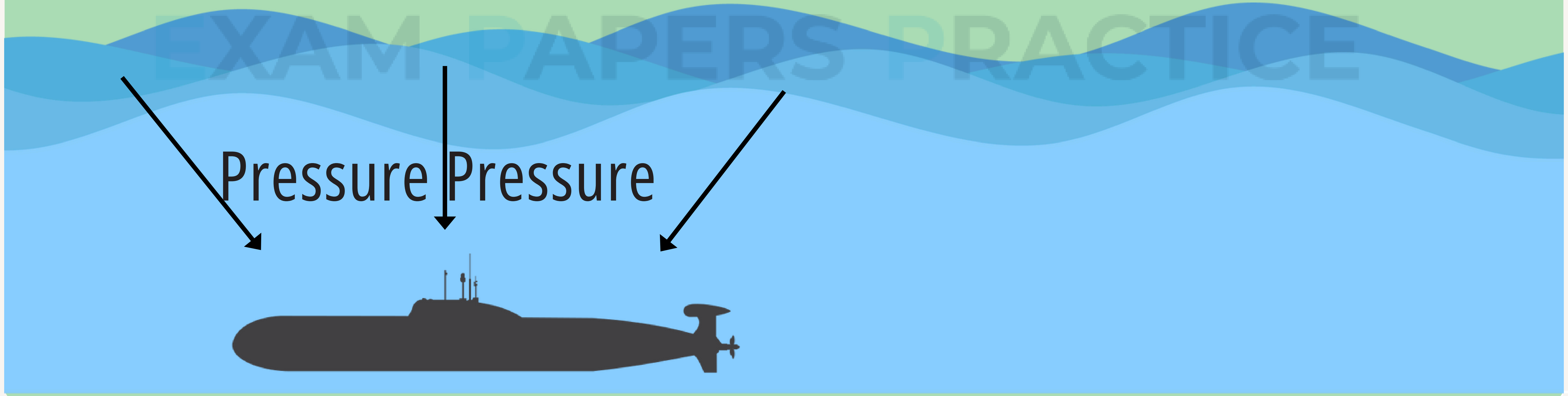
PRESSURE

We experience pressure when we are: **UNDER WATER**

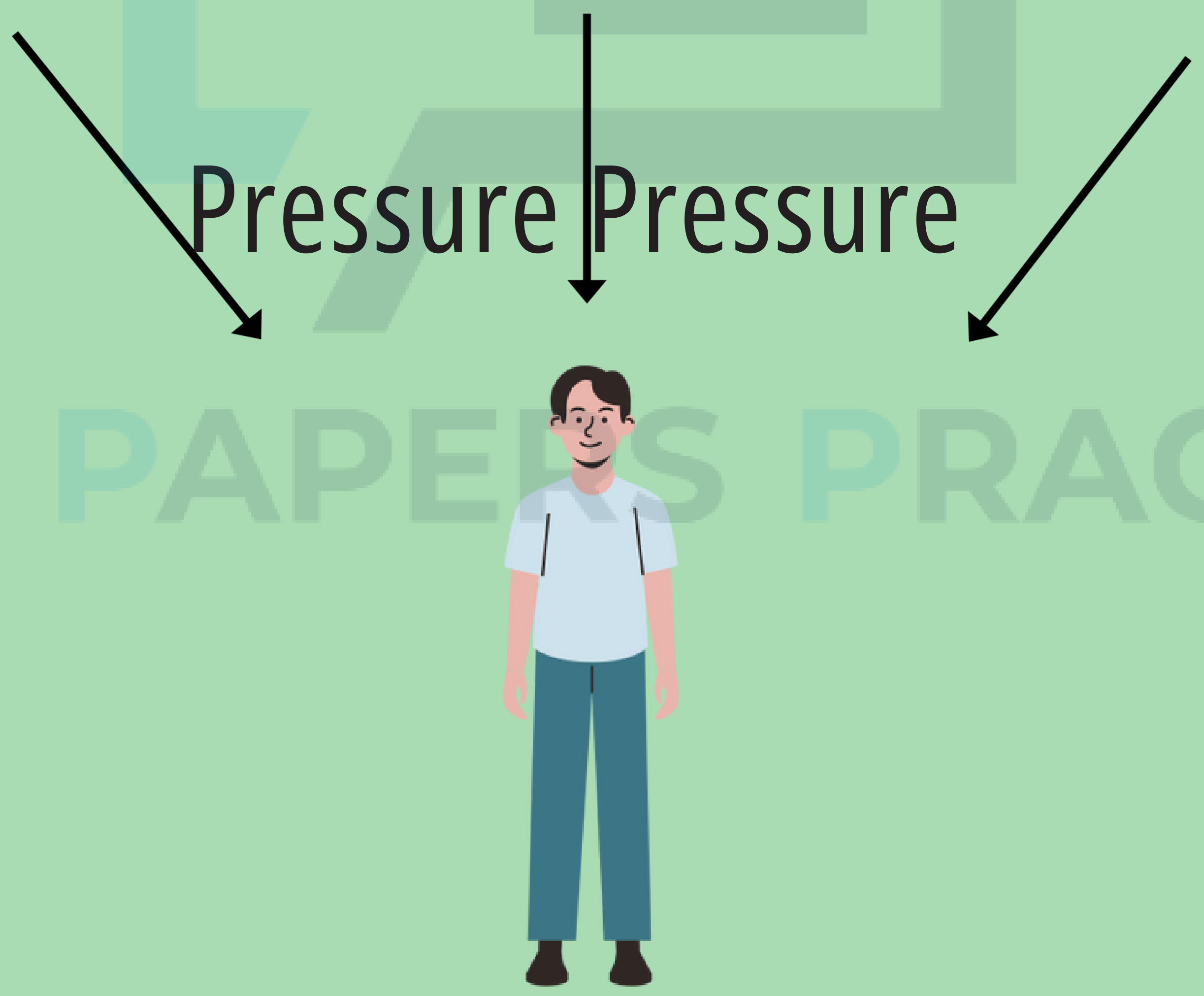
Submersion underwater results in pressure due to the weight of water above pressing down on any submerged object. Deeper depths lead to increased water pressure.



PRESSURE

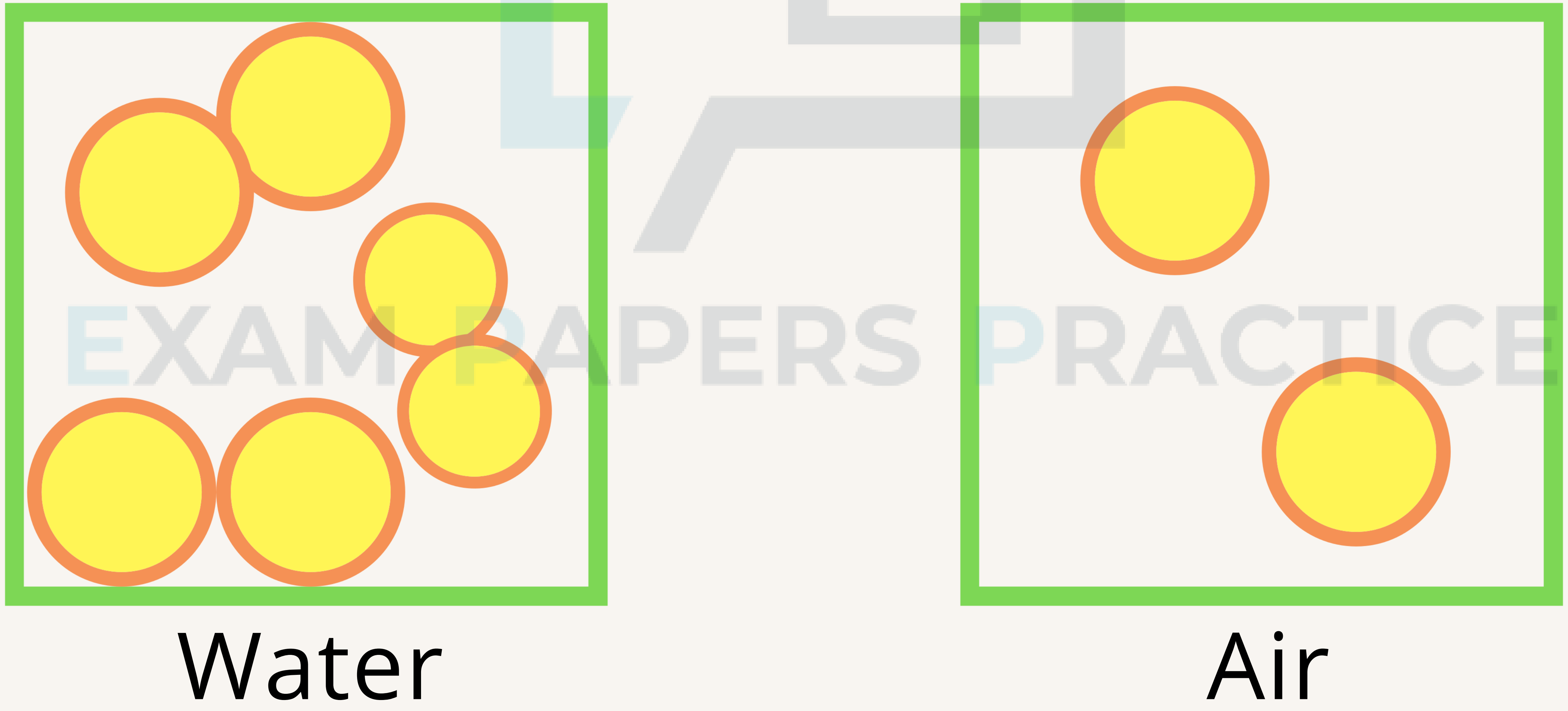
We experience pressure when we are: **ON EARTH**

We experience atmospheric pressure (about 101325 Pa)



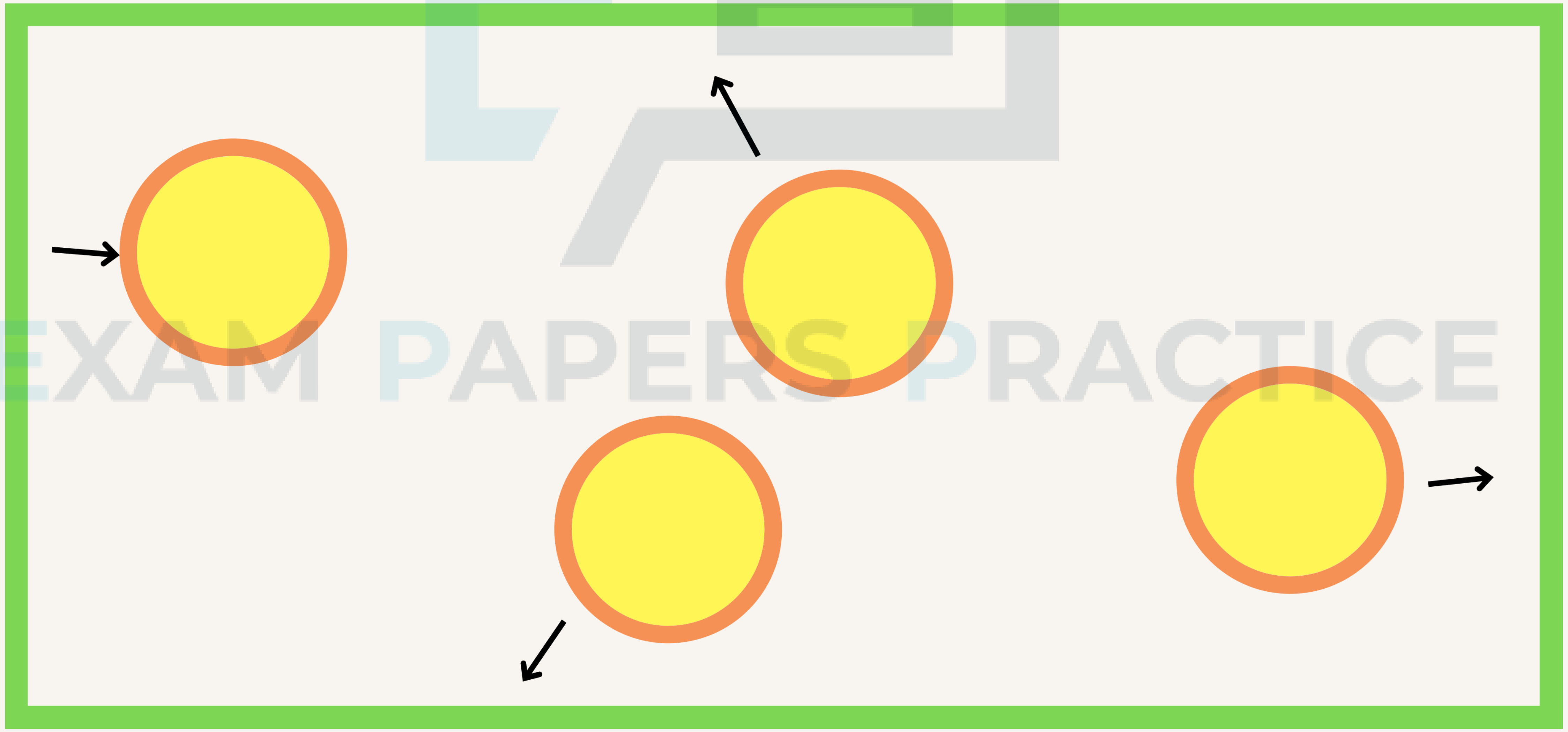
PRESSURE

Water exerts significantly higher pressure compared to air because water is much denserthan air.



PRESSURE

Pressure arises from the impact of molecules collidingwith every surface they encounter.



CALCULATING PRESSURE

Pressure is the force per unit area acting on a surface.

Equation

P = F / A

Units:

N / M_2

Pascal

INTUITION

Equation

$P = F / A$

WORKED EXAMPLE

Which exerts greater pressure: a force of 300 N acting on $0.5\ m^2$, or the same force acting on $1.0\ m^2$?

[redacted]

WORKED EXAMPLE

Which exerts greater pressure: a force of 300 N acting on 0.5 m^2, or the same force acting on 1.0 m^2 ?

P = F / A

= 300 / 0.5

= 600 Pa

P = F / A

= 300 /1

= 300 Pa

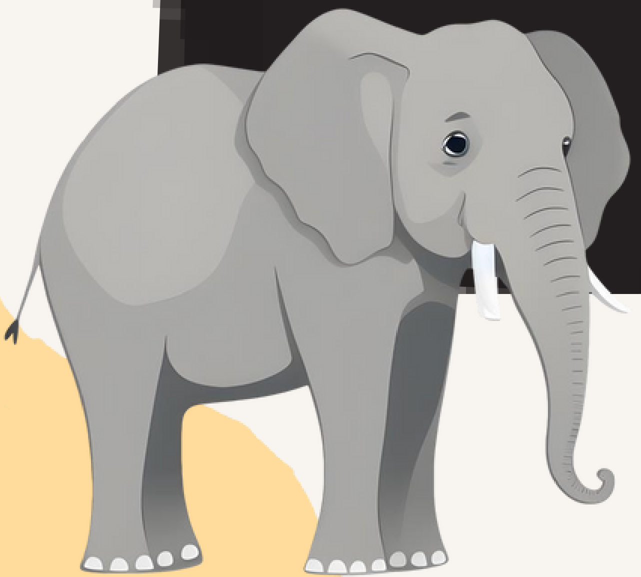
Answer:

A force acting on smaller area has greater pressure.

WORKED EXAMPLE

What pressure is exerted by an elephant weigh 60000 N acting on 1.2 m^2?

[redacted]



WORKED EXAMPLE

What pressure is exerted by an elephant weigh 60000 N acting on 1.2 m^2?

$P = F / A$

$= 60000 / 1.2$

$= 50000$ Pa

CALCULATING PRESSURE

We have seen that the deeper one dives into water, the greater the pressure.

CALCULATING PRESSURE

Pressure under liquid depends on:

a. Depth (we use the letter h, for height)

b. Density (we use the letter p)

CALCULATING PRESSURE

Equations for pressure under liquid:

Equation

Pressure = pgh

Height

Density of liquid

Gravitational field strength

WORKED EXAMPLE

Determine the pressure at the base of a lake that is 3.0 meters in depth. How does this pressure compare with atmospheric pressure, which is 101, 325 Pa? (Density of water is 1000 kg/m^3).

[redacted]

WORKED EXAMPLE

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Pressure = pgh

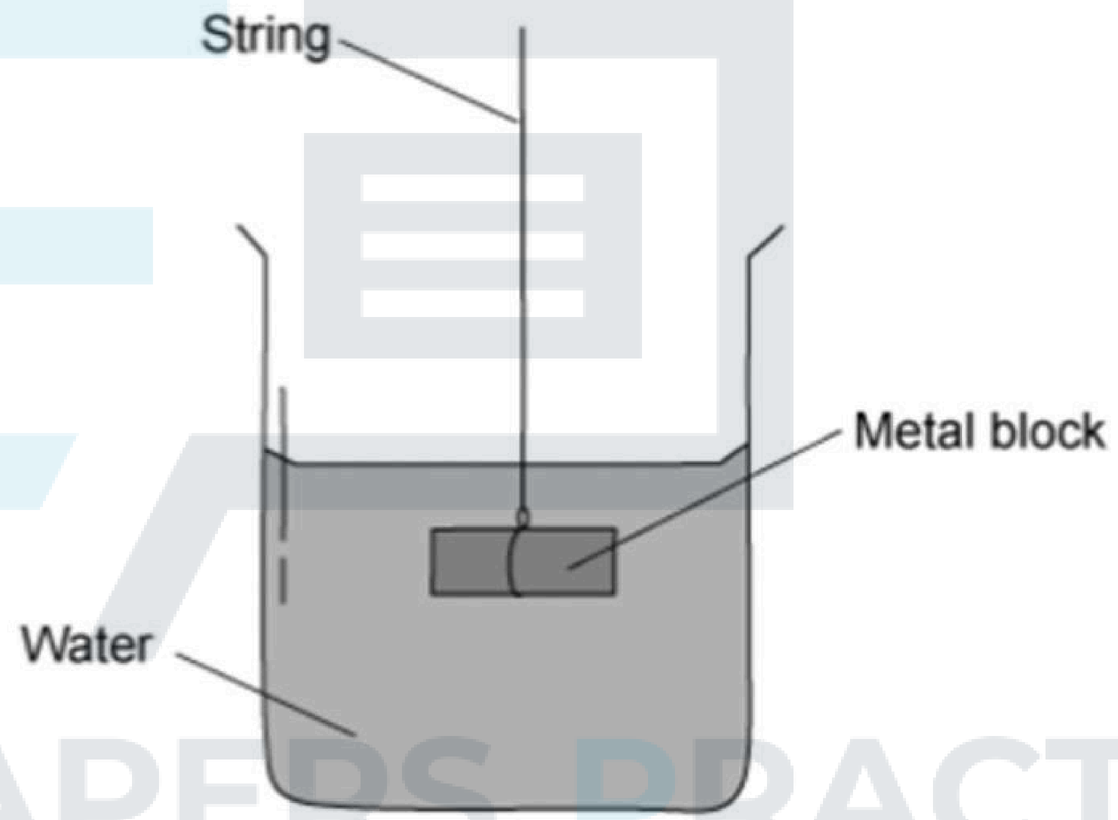
= 1000 (9.8) (3)

= 29400 Pa

The atmospheric pressure is larger than pressure under the lake.

A small metal block is suspended under the surface of a beaker of water by a string.

The metal block experiences a pressure exerted by the liquid.



What would increase the pressure exerted on the metal block?

A increasing the surface area of the stone

B using a liquid with a lower density

C increasing the mass of the metal block

D lowering the metal block deeper into the liquid

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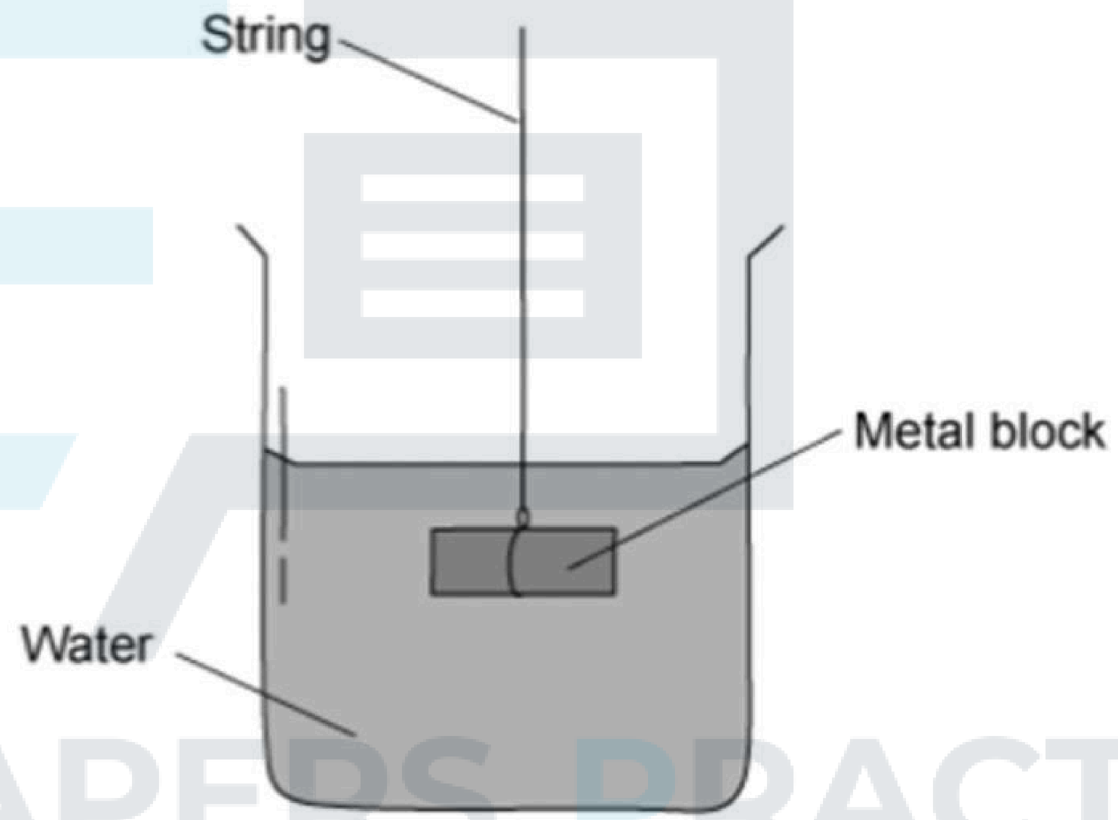

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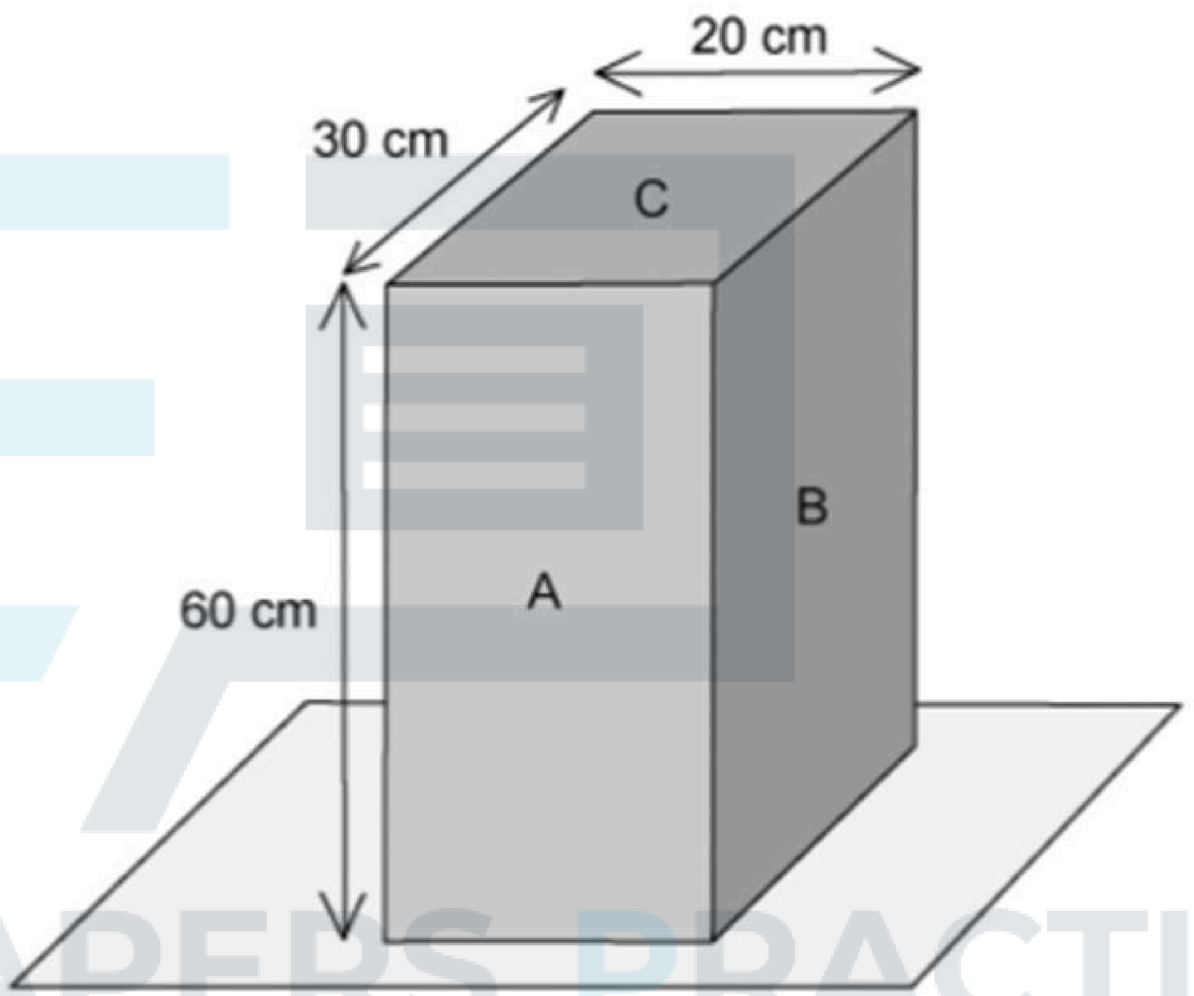
A wooden block rests on a table.



On which surface should the block be laid to produce the largest pressure on the table?

A A.

B B

C C

D Any side, they will all produce the same pressure

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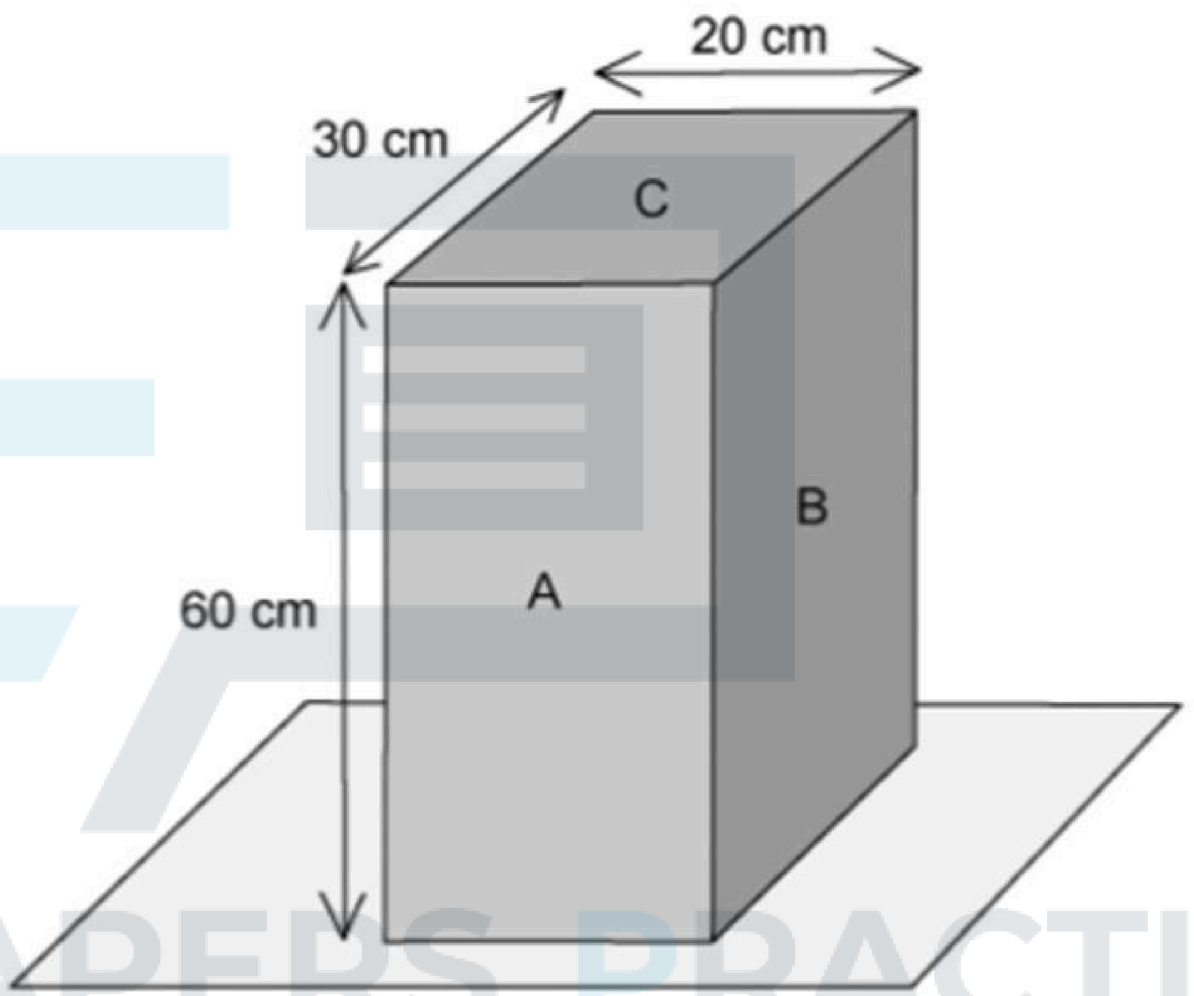

On which surface should the block be laid to produce the largest pressure on the table?

A A.

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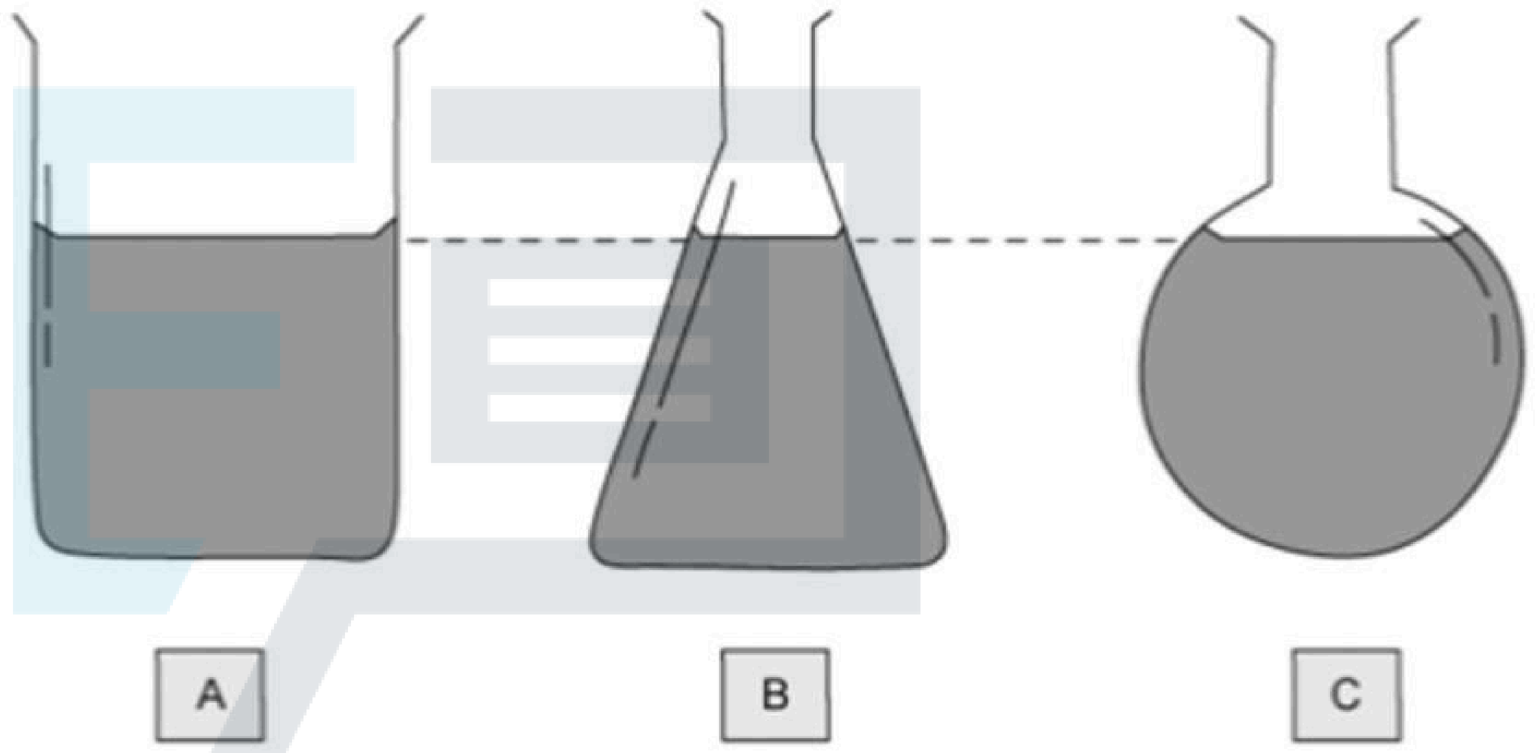
Three beakers of water are placed on a table. The depth of water in each container is the same.



In which container does the water exert the greatest pressure on the base of the container?

A A

B B

C C

D None, the pressure is the same in all three.

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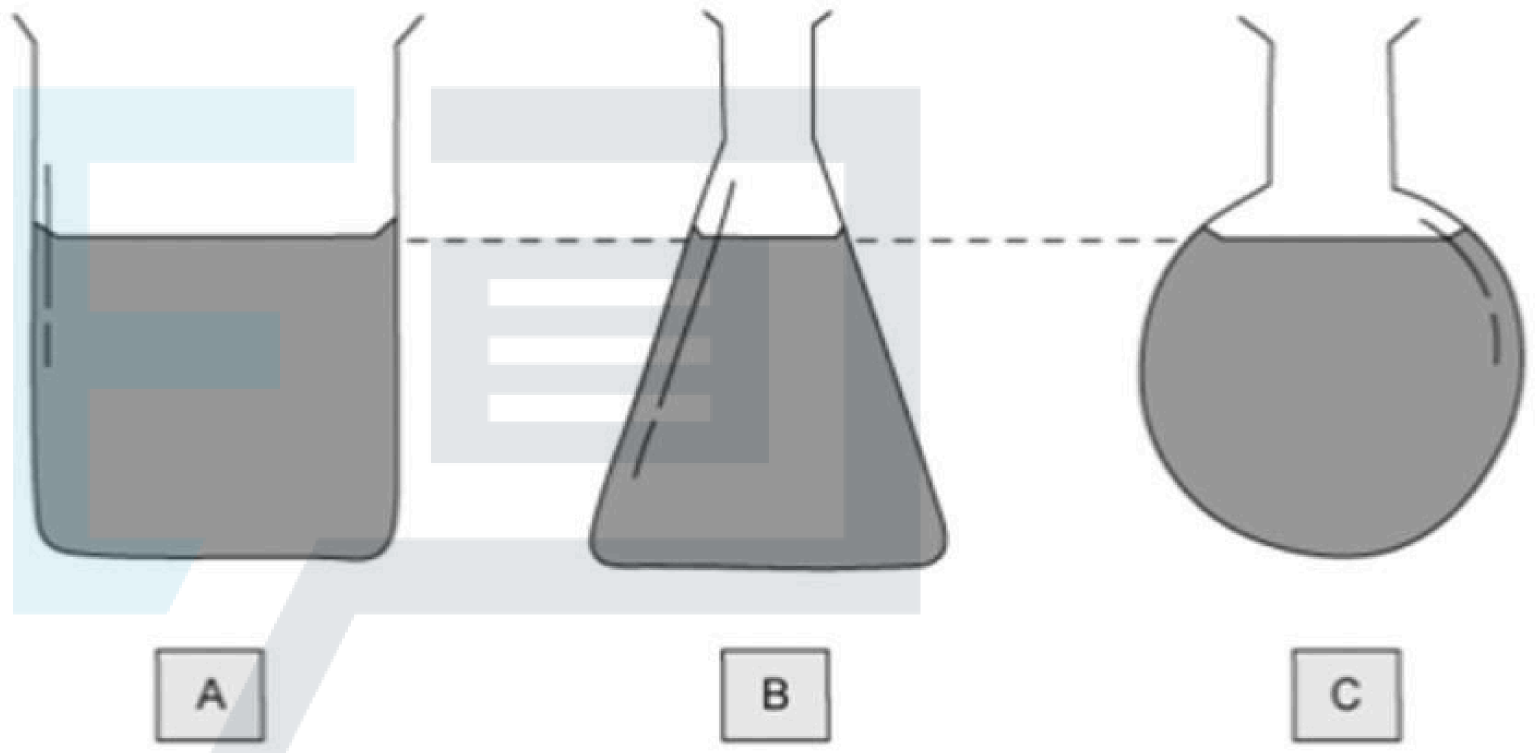


In which container does the water exert the greatest pressure on the base of the container?

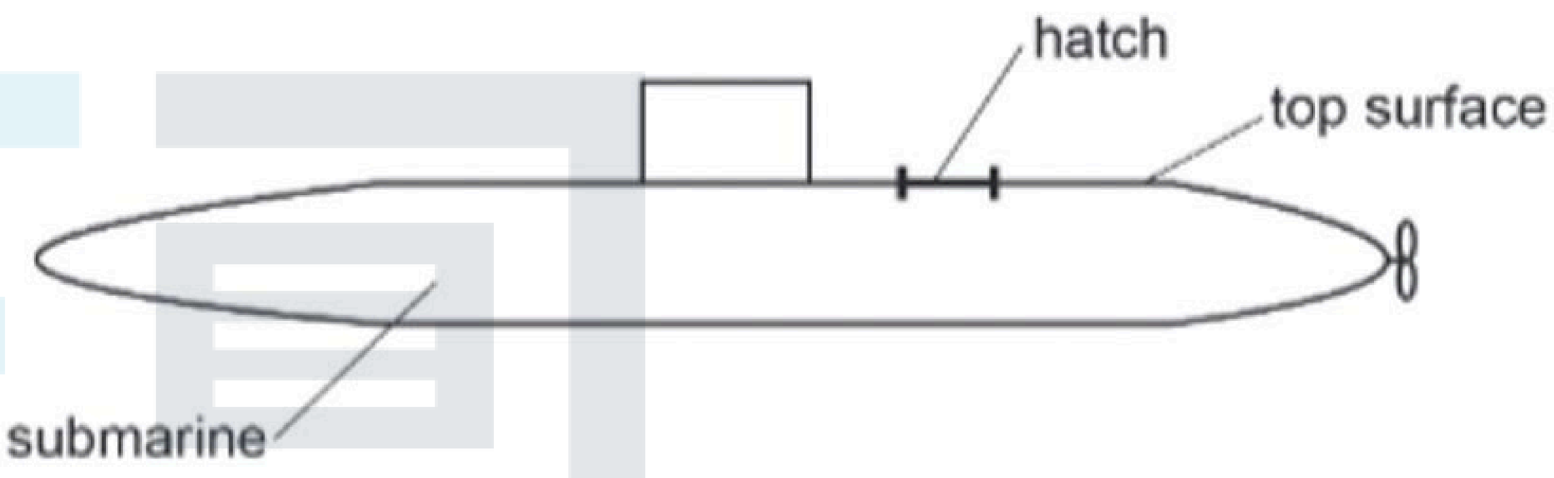
A A

B B

C C

D None, the pressure is the same in all three.

1 The diagram shows a submarine. The submarine is fully submerged in the sea.



The density of sea water is $1020\,kg/m^3$.

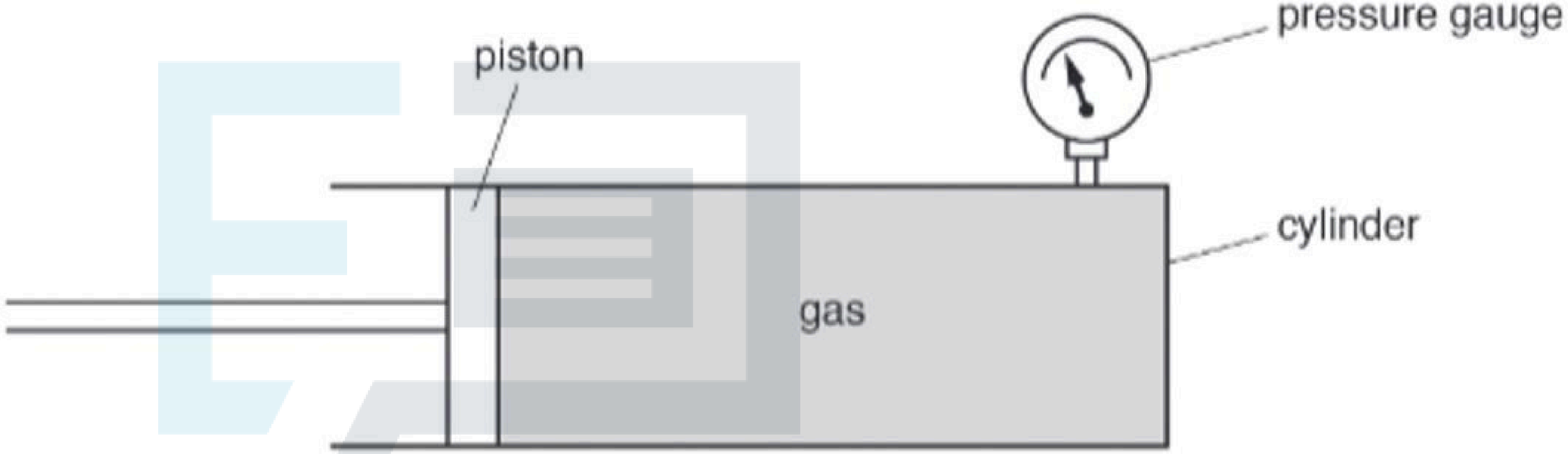
The atmospheric pressure is 100 kPa and the total pressure on the top surface of the submarine is 500 kPa.

Calculate the depth of the top surface of the submarine below the surface of the sea.

depth = ... [3]

Answer	Marks
P = ρgh in any form (1) (h =) $400 \times 10^3 / (1020 \times 10)$ (1) (h =) 39 m (1)	3

The diagram shows a gas contained in a cylinder enclosed by a piston.



Describe, in terms of momentum of the molecules, how a pressure is exerted on the walls of the cylinder.

....

....

....

....

.... [3]

Answer	Marks
they / molecules collide with walls (1) change of momentum causes force (to be exerted on walls) (1) pressure = force / area (so pressure is exerted on walls) (1)	3