1.2 Squashing and stretching

Learning objectives

After this topic you will be able to:

- describe how forces deform objects
- explain how solid surfaces provide a support force
- use Hooke's Law.

Why don't you fall through the chair you're sitting on? The chair changes shape, or deforms, when you sit on it. This produces the force that pushes you up.

Changing shape

When a ball hits the floor the ball **deforms**. Forces can **compress** (squash) or **stretch** objects. When you exert a force you can deform an object. You can compress it or you can stretch it.

A Describe what happens to a tennis ball when it hits the ground.

▲ Even a solid golf ball changes shape when you hit it.

Foul Fact!

When a footballer heads a ball the forces deform both the ball and the footballer's head.

Link

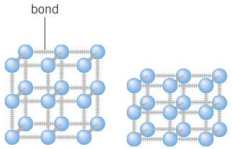
You can learn more about particles in solids, liquids, and gases in C1 1.1 The particle model

Key Words

deform, compress, stretch, reaction, extension, tension, elastic limit, Hooke's Law, linear

How can the floor push you up?

The floor pushes up on you when you stand on it. It seems strange to talk about the floor exerting a force on you. You can't see anything happening.



◀ These diagrams show what happens when you exert a force on a solid object.

You compress the bonds when you exert a force.

The floor is a solid; solids are made up of particles arranged in a regular pattern. The particles are joined strongly together by bonds. This is what happens when you stand on the floor:

- Your weight pushes the particles together.
- The bonds are compressed.
- They push back and support you.

Solid materials are only compressed a very small amount when you apply a force to them. A support force from a chair or the floor is called the **reaction** force.

Stretching

Bungee cords, springs, and even lift cables all stretch when you exert a force on them. The amount that they stretch is called the **extension**.

A bungee cord stretches as the jumper falls. When the bungee cord has stretched as far as it will go, it pulls her back up. This force is called **tension**.

What happens when you stretch a spring?

Springs are special. If you *double* the force on the spring the extension will *double*. You can use the length of the spring to measure the size of a force. When you remove the force the spring goes back to its original length.

What's the limit?

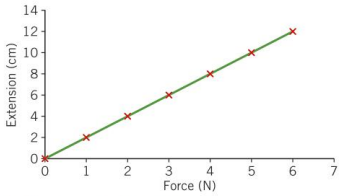
At some point the spring will not go back to its original length when you remove the force. This is the **elastic limit**. Trampoline springs are designed to never go past their elastic limit.

◀ The shape of a bungee cord changes when you stretch it.

Hooke's Law

If the extension doubles when you double the force then the object obeys **Hooke's Law**. The graph of force against extension is a straight line, or **linear**. Hooke's Law is a special case. Not everything behaves like a spring when you stretch it. If you double the force on an elastic band the extension may not double.

B State Hooke's Law.



▲ This graph shows how the extension of a spring changes as you pull it.

A straight-line graph

Using the graph below, find the extension when the force is 3 N and again when it is 6 N. Does this spring obey Hooke's Law? Explain your answer.

How long?

You have a spring that is 4 cm long. When you exert a force of 3 N it stretches to a length of 6 cm. What is the extension? What would the extension be if you doubled the force?

Summary Questions

1 Copy and complete the sentences below.

Forces can change the shape of objects or _____ them. Solid surfaces are made of _____. The bonds between particles are compressed when you apply a force. They _____ back on you. This provides a _____ force called the _____ force.

(5 marks)

2 Describe how your chair pushes you up.

(2 marks)

3 Design a new style of trampoline that would make trampolining more fun. Use the ideas on this page to explain how it works.

(6 marks)