

**CONCEPT REVIEW 48**


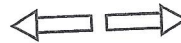



Complete this concept review handout and keep it as a record of what you have learned.

# Constraints and material deformations

## Definition

- A constraint describes the effect of external forces on a material.

## Main types of constraints materials are subjected to

Type of constraint	Description	Symbol
Compression	<u>When a material is subjected to forces that tend to crush it.</u>	
Tension	<u>When a material is subjected to forces that tend to stretch it.</u>	
Torsion	<u>When a material is subjected to forces that tend to twist it.</u>	
Deflection	<u>When a material is subjected to forces that tend to bend it.</u>	
Shearing	<u>When a material is subjected to forces that tend to cut it.</u>	

## Types of material deformation

Type of deformation	Description
Elastic	<u>The constraint leads to a temporary change in the shape or dimensions of the material.</u>
Plastic	<u>The constraint leads to a permanent change in the shape or dimensions of the material.</u>
Fracture	<u>The constraint is so intense that the material breaks.</u>

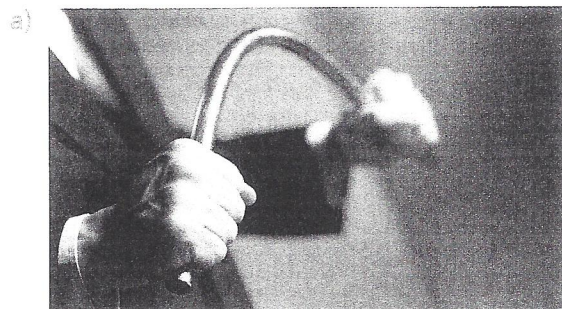




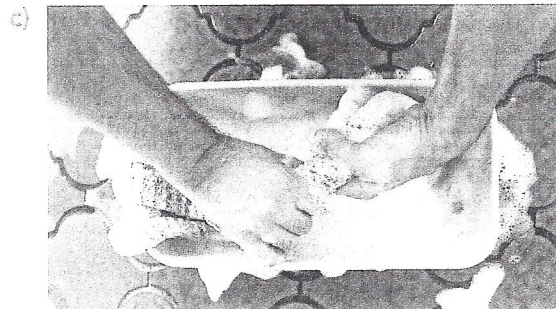
## INTEGRATION QUESTIONS

### Constraints and material deformations

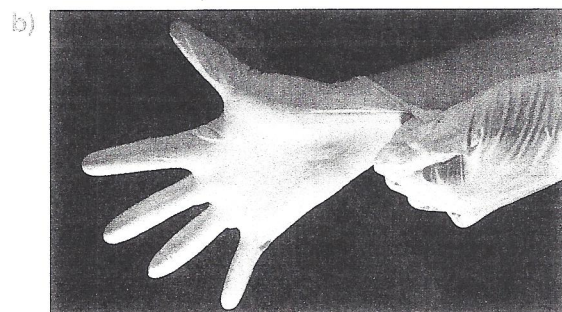
1. In each of the illustrations below, indicate which type of constraint the material is being subjected to.



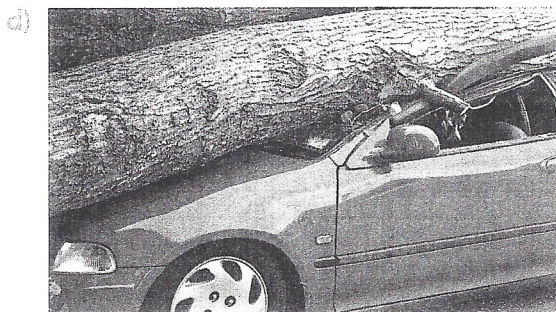
*A deflection constraint.*



*A torsion constraint.*



*A tension constraint.*



*A compression constraint.*

2. What type of deformation are the objects in the following situations subjected to?

a) You insert paper into a shredder.

*Fracture.*

b) You tread on a discarded cardboard container on the sidewalk.

*Plastic.*

c) The roof of your carport sags under the weight of snow.

*Elastic.*

d) You drive your car over a small bicycle.

*Fracture or permanent.*

e) You flatten a milk container before tossing it in the recycling box.

*Plastic.*

3. New foam mattresses exist that mould to the shape of your body when you sleep, and spring back to their original form when you get out of bed. Describe this situation in terms of constraints and material deformations.

*Answers will vary. Example: The mattress is subjected to a compression constraint that results in an elastic deformation.*





# Properties and material degradation and protection

PAGES 388 TO 390

## CONCEPT REVIEW 49

Complete this concept review handout and keep it as a record of what you have learned.

### Definitions

- The mechanical properties of a material describe how it reacts when subjected to one or more constraints.
- The degradation of a material is the decline in some of its properties due to the effects of the surrounding environment.
- The protection of a material is the application of procedures that prevent or delay its degradation.

### Mechanical properties of materials

Mechanical property	Definition
Hardness	Ability to resist indentation or abrasion.
Elasticity	Ability to return to their original shapes after undergoing a constraint.
Resilience	Ability to resist shocks without breaking.
Ductility	Ability to be stretched without breaking.
Malleability	Ability to be flattened or bent without breaking.
Stiffness	Ability to retain their shapes when subjected to various constraints.

### Other properties of material

Property	Definition
Resistance to corrosion	Ability to resist the effects of corrosive substances (such as water, various salts and some components of smoke), which cause, for example, the formation of rust.
Electrical conductivity	Ability to carry an electric current.
Thermal conductivity	Ability to transmit heat.





## INTEGRATION QUESTIONS

### Properties and material degradation and protection

You will need Appendix 5 in the textbook, which is reproduced on page 268 of this book and on the inside back cover, to answer Question 2.

1. What am I? Indicate the property described in each of the statements below.

a) I enable a material to resist being crushed.

Hardness or stiffness.

b) With me, a material returns to its original shape.

Elasticity.

c) I allow a material to keep its shape even when subjected to a strong constraint.

Stiffness.

d) I let a material flatten without any risk of breaking.

Malleability.

e) Without me, a material might break if it was stretched.

Ductility.

2. Name a property that influenced engineers in their choice of materials when they designed the following objects.

a) Chrome for car bumpers.

Answers will vary. Examples.

Resistance to corrosion or hardness or resilience.

b) Copper for electrical wires.

Electrical conductivity or ductility.

c) Iron for buildings.

Ductility.

d) Rubber for bicycle tires.

Malleability or elasticity.

e) Aluminum for rowboats.

Malleability or resistance to corrosion.

3. Study the photo opposite.

a) Explain why the materials of the bike have changed.

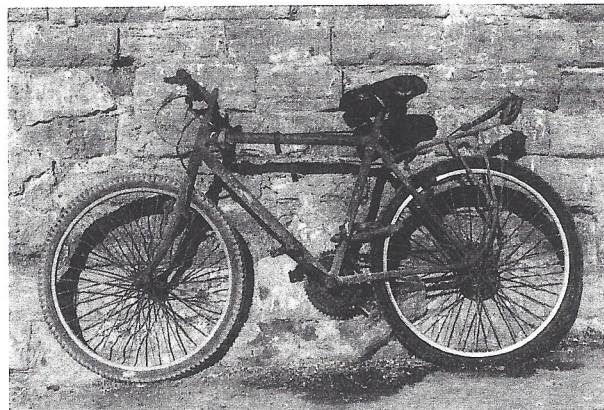
The bike has been attacked by rust.

The materials are degrading.

b) How could the problem have been avoided?

By rustproofing the bike, with paint,

for example, like a painting.



4. Give two examples of things that cause material degradation.

Answers will vary. Examples. Water can cause material degradation along with pollution, sun, heat, weather, improper use, etc.

