Living with Thermal Expansion and Contraction

Key Question: How do thermal expansion and contraction affect everyday objects?

Temperatures change all the time. In general, days are warmer than nights. Other places change temperature with the seasons.

Remember that the three main states of matter are:
1. solid
2. liquid
3. gas

Most matter expands when heated. Most matter contracts when cooled. This is true for every state of matter.

Expansion and Contraction of Solids

People who design structures such as buildings and bridges are very careful about the materials they use. They choose materials that will not break when temperatures change.

A building project will often require two or more materials. Designers should not choose materials that expand and contract in different ways. One material might expand faster than another material. If this happens, there could be damage to the structure.

Think about solid materials you use or see every day. A few examples of solids that expand and contract are
• metal frames around windows
• hot-water pipes in homes
• railroads
• car engines
• metal lids on jars
What would happen if these materials were damaged?

You may think that a tooth does not change, but teeth can expand and contract like other materials. When you have a cavity, the dentist removes the decayed part and fills it in.

Some scientists work on making new filling materials. They want these fillings to expand and contract just like real teeth.

**Building with Concrete**

Engineers use steel rods to make concrete bridges and buildings stronger. The rods help support the concrete. The steel needs to expand and contract in the same way that the concrete does.

If the steel does not expand at the same rate as the concrete, the concrete can crack. Eventually the building could fall.

Bridges and sidewalks are built in sections. There are spaces between the sections called expansion joints (Figure 1). Expansion joints allow steel and concrete to expand without cracking.

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**Figure 1** (a) The expansion joints narrow when bridge segments expand in hot weather. (b) Expansion joints in a bridge separate when the side-by-side segments of a bridge contract in cold weather.
EXPANSION AND CONTRACTION OF GASES

Gases that are heated will expand in their containers. The energy of the gas particles will increase. The particles of warm gases hit the walls of the container more often. They also hit the walls harder.

If the walls of the container are flexible, the walls expand. If the walls are not flexible and cannot expand, then the pressure inside the container increases.

Think about gases you use or see every day. A few examples of gases that expand and contract are

• air in tires
• air in a soccer ball
• air in balloons (Figure 2)
• air in an air mattress

Figure 2 The helium gas in a balloon expands when you move a balloon from the cold outdoors to a warm room. (a) At a low temperature, the average kinetic energy of the particles in the balloon is low. The particles do not collide as often with the walls of the balloon, and hit the walls with less force. So, the balloon contracts.
(b) As the temperature of the gas inside the balloon rises, the particles move faster and hit the wall of the balloon more often. So, the balloon expands.
What would happen if those materials did not expand and contract as they are meant to?

When cars and bicycles travel, their tires rub on the road. This makes the tires get hot. The air inside the tires will expand. If the tires are too full, they could burst.

Sports balls such as soccer balls are also filled with air. If you leave a soccer ball out in the cold, the air inside the ball will contract. The ball will get soft and it will become unusable.

**Expansion and Contraction of Liquids**

Think about liquid materials you use or see every day. A few examples of liquids that expand and contract are

- gasoline in cars (Figure 3a)
- engine coolant
- oceans and lakes
- alcohol in thermometers (Figure 3b)

What would happen if these materials did not expand and contract as they are meant to?

In the last 100 years, the temperatures of oceans and lakes on Earth increased. Warmer oceans and lakes have a greater volume. When oceans have larger volumes, sea levels rise. If there is enough of an increase, coastal cities can flood.

**Figure 3** (a) Gasoline expands during hot weather. A full tank on a warm day could overflow. (b) The liquid in a thermometer expands and contracts as the air becomes warmer or cooler.
1. Name two solid structures that expand and contract.

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2. Name two liquids that expand and contract.

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3. What would happen to a bridge that did not have expansion joints? Explain.

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4. Correct this statement to make it true: “The particles in a material get bigger when heated.”

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5. Think back to the Key Question. Identify two examples of thermal expansion or thermal contraction you have seen or used. Record your answers in the table below.

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<th>Example of thermal expansion or contraction</th>
<th>How it affects you</th>
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