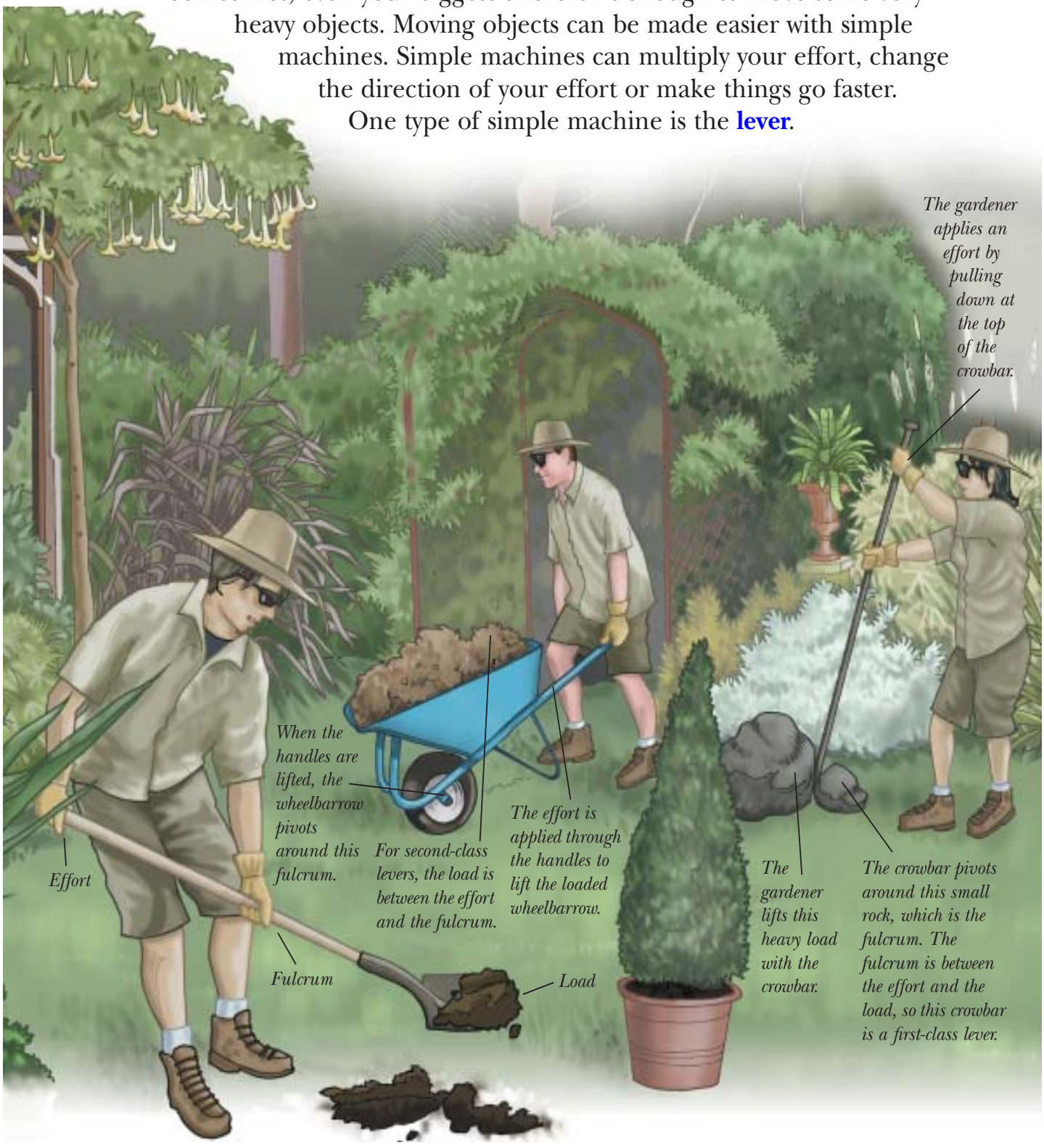
# In the garden

It would be difficult to move a pile of rocks from one end of the garden to the other by hand. It takes much less **effort** using a wheelbarrow. The effort you use is actually a **force**.

Sometimes, even your biggest effort isn't enough to move some very heavy objects. Moving objects can be made easier with simple machines. Simple machines can multiply your effort, change the direction of your effort or make things go faster. One type of simple machine is the **lever**.



## Using levers

A lever is usually a long, rigid object that moves around a turning point called a **fulcrum**. You need to put in an effort to make the lever move a **load**. Levers are named according to where the fulcrum, load and effort are positioned along the lever.

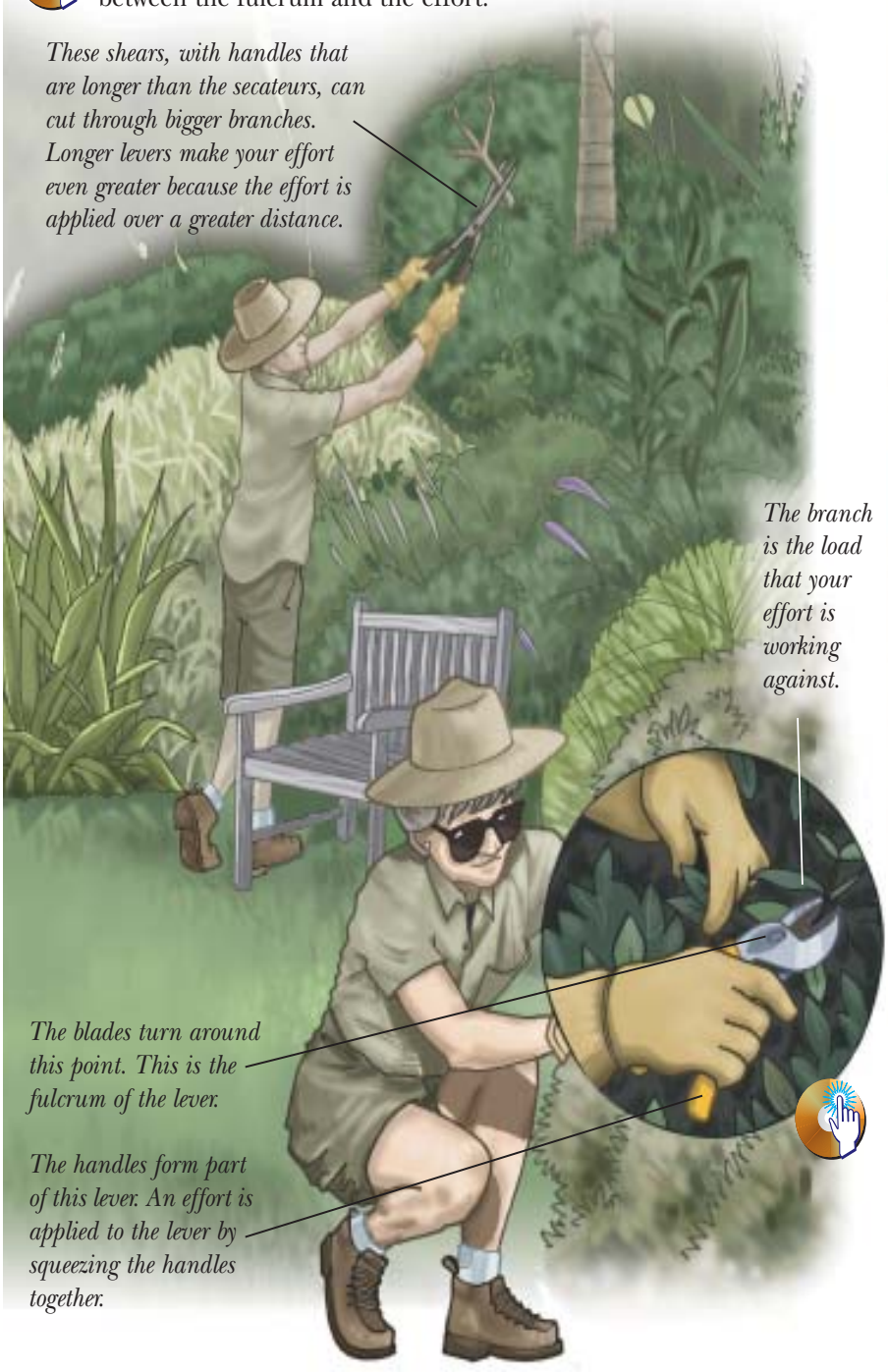
### First-class levers

**First-class levers**, such as the shovel, secateurs and shears below, turn around a fulcrum that is between the effort and the load. All first-class levers are **force multipliers**. They magnify your effort. This means that you may be able to move loads that you couldn't move without the lever.

### Second-class levers

**Second-class levers** are also force multipliers. They turn around a fulcrum that is at the end of the lever. For second-class levers, the load is always between the effort and the fulcrum.

The wheelbarrow is a second-class lever. It is used to move objects that would otherwise be too heavy to carry. The *load* in a wheelbarrow is between the fulcrum and the effort.




## Activities

### REMEMBER

1. What do you call the force you apply to a lever to move an object?
2. Explain how a first-class lever is different from a second-class lever.
3. Why are first- and second-class levers called force multipliers?

### THINK

4. Two wheelbarrows are identical, except for the length of their handles. Which would you prefer to use? Why?
5. Sketch and label the effort, fulcrum and load in each of the following diagrams. State whether each is a first- or second-class lever.

(a)

(b)

(c)

### ✓ checklist

I can:

- ☐ compare first- and second-class levers
- ☐ identify the effort, fulcrum and load in a lever system.

# Living levers

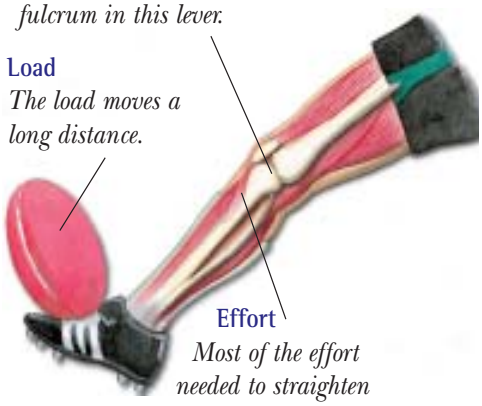
The long bones in our arms and legs act as **levers**.

Our joints form fulcrums and our muscles apply a **force** to the bones to make them work. Many of the levers in our bodies are **third-class levers**.

Third-class levers are those in which the effort is between the fulcrum and the load. All third-class levers are **speed multipliers**. A big effort needs to be applied, but the load moves over a greater distance, at a higher speed.

Some sports make use of more than one type of simple machine. Woodchopping uses the arm and axe together as a third-class lever. The axe blade strikes the wood block at a high speed. The blade itself is another simple machine called a **wedge**. A wedge pushes objects apart. In this case, the axe blade splits the piece of wood into two parts.

The leg below is acting as a third-class lever. The effort is between the fulcrum and the load.

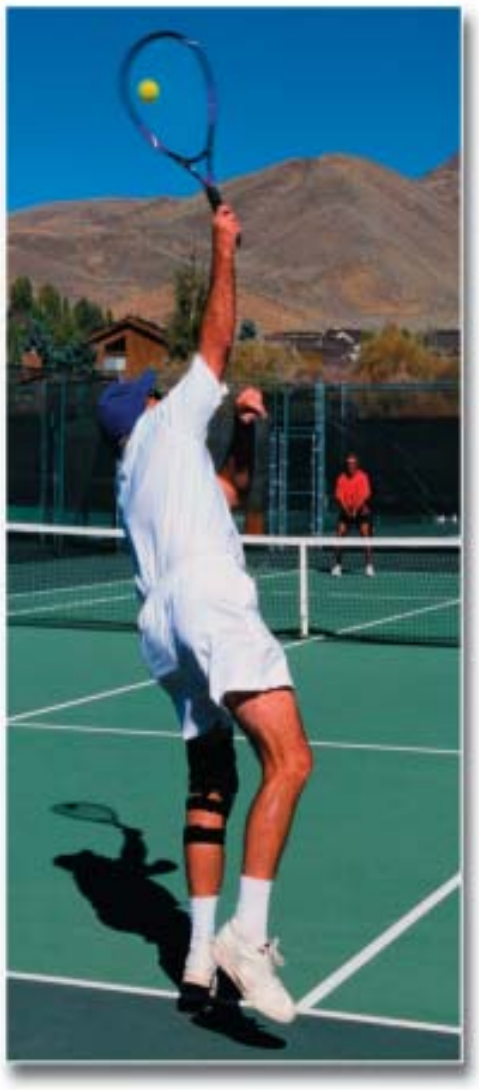



## Levers in sport

In sport, levers are usually used to increase the speed of a load and the distance over which it travels. Tennis racquets, cricket bats and softball bats are all third-class levers. They are used to make objects move faster and further.

The longer the distance between the load and the effort, the faster the load will move. Tennis players reach up high when they serve. This way, the lever formed by the arm and the racquet is much longer.

A fast serve can measure over 200 km/h. Greg Rusedski has served at a speed of 239.8 km/h. Mark Philippoussis has served up to 226.9 km/h.

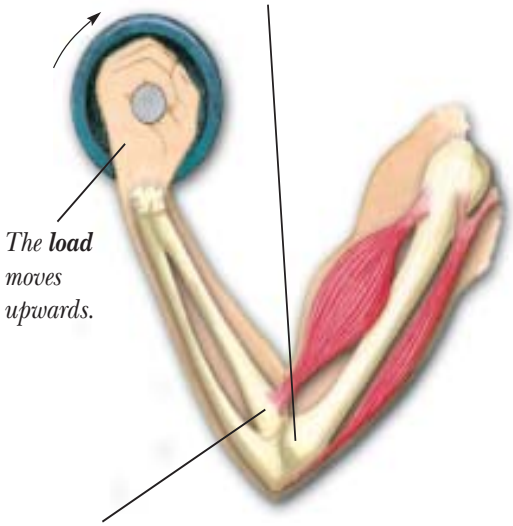


## Different classes of lever in the arm

Bending and straightening the arm uses two different classes of levers.

***Bending the arm***

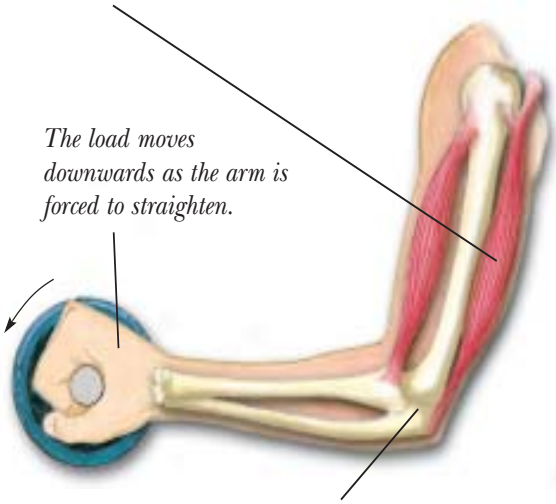
*The elbow is the **fulcrum** because it forms the pivot point for the movement of the arm.*




*The forearm provides the **effort** through its connection to the biceps muscle below the elbow. Therefore, the effort is between the fulcrum and the load, making the forearm into a third-class lever.*

***Straightening the arm***

*This muscle is called the triceps muscle. It provides the effort used to straighten the arm. You use your triceps muscle when you push a heavy load down. The triceps are also used to shoot goals in basketball and netball.*




*The triceps muscle attaches to the elbow, which is the fulcrum. The fulcrum is between the effort and the load, so your forearm acts as a **first-class lever**.*

## Activities

### REMEMBER

1. Explain how third-class levers are different from first- and second-class levers.
2. (a) Label the effort, fulcrum and load along the fishing rod.
   (b) What class of lever does the fishing rod act as?

### THINK

Some sports, like rowing, do not rely on speed alone. It is very difficult to move through water, so a **force multiplier** is needed to help the rowers.

3. (a) What class of lever do these oars form?
   (b) What other sports use force-multiplying levers?
4. Do you think that humans are built for speed or for strength? Explain your answer.

### INVESTIGATE

5. Choose a sport not already mentioned on this page.
   (a) Explain how levers are used in this sport.
   (b) What classes of levers are used?
   (c) Why are these types of levers used?
   (d) Draw a labelled diagram to show how the levers are used in your chosen sport.

✓ checklist

I can:

- ☐ distinguish between speed-multiplying levers and force-multiplying levers
- ☐ explain how levers are used in a variety of sports.