Which of the following actions will **not** reduce friction?
(A) making one surface smoother
(B) oiling one surface
(C) making one surface rougher
(D) greasing one surface

In a first order lever:
(A) the fulcrum is between the load and the effort
(B) the load is between the fulcrum and the effort
(C) the effort is between the fulcrum and the load
(D) the fulcrum is at the opposite end to the load

An example of a second class lever is:
(A) a pair of scissors
(B) a crowbar
(C) a spade
(D) a wheelbarrow

In which of these methods is friction not useful.
(A) opening a door (B) walking down a hill
(C) cutting with a saw (D) sitting on a bicycle

(Macmillan; Macmillan Primary Science, Pupil's book 7 P.138）

A fishing line and a spade have the same arrangement of the fulcrum.
Which **one** of the following statements about the two levers is correct?
A. The effort is between the fulcrum and the load
B. The fulcrum is between the effort and the load
C. The load is between the fulcrum and the effort
D. The effort is close to the load

Which one of the following materials does **not** increase friction?
A. Sand B. Murram
C. Marbles D. Rubber

(KLB; Primary Science Pupils' Book for Standard Seven P.174）

Appendix

Evaluation problems, written by Dr. Takemura

The PISA tests are administered to participating 15 year-old youths in 57 nations worldwide. Many nations worldwide are moving in this direction, from which Kenya and other African countries will benefit in the future. Several African countries already participate in PISA testing.

In particular, the PISA test is an evaluation of **scientific ability** developed through the learning process of science for children.

1. Evaluate the ability to predict changes in examined problems.

- Which of these is a scientific problem examining the principles behind balancing a lever?
  1) Are the force acting upon the effort and the force working on the load the same?
  2) What is the heaviest stone you can lift using your full power with a lever?
  3) With the fulcrum in the centre, when will the force acting to lift a lever from the effort and force acting to lift a lever from the load be level?
  4) Archimedes made war tools which used levers. What kind of tools were these?

2. Evaluate the ability to predict changes in problems examined.

- Pupils are examining the work lifting a lever. They are trying various things and making predictions. Which of the following predictions is not correct?
  1) The more force applied to the effort, the more force you will have acting upon the load.
  2) The longer the distance between the fulcrum and the effort, the more force you will have acting upon the load.
  3) The shorter the distance between the fulcrum and the load, the more force you will have acting upon the load.
  4) The longer the distance between the fulcrum and the effort, the bigger the force gets, meaning more force will be put on the fulcrum.

3. Evaluate the ability to specify the cause of changes.

- Pupils have the fulcrum in the centre and are trying to find out by experiment what the work lifting a lever is related to. Which of the following is not related to the work of a lever?
  1) The difference in distance from fulcrum to effort
  2) The difference in distance from fulcrum to load
  3) The difference in magnitude of the force put upon the effort
  4) The difference in length of the lever's arms

4. Evaluate the ability to clarify how to observe an experiment.

- You are planning an experiment in which pupils examine how the **difference in length from fulcrum to effort** is related to the work acting to lift a lever. Which of the following is the most applicable experiment plan?

1) Change the **length from fulcrum to effort**, examine **force put upon the load** and **force put upon the effort**, and examine how these two forces combined equal the **force put upon the fulcrum**.
2) Change the **length from fulcrum to effort** and **length from fulcrum to load**, and setting the **force put upon the effort** as constant without changing it, examine the change in **force working upon the load.**
3) Change the **length from fulcrum to effort**, and setting both the **force put upon the effort** and the **distance from fulcrum to load** as constant without changing them, examine the change in **force working upon the load.**
4) Change the **length from fulcrum to effort**, **force put upon the effort** and the **distance from fulcrum to load**, and examine the change in **force working upon the load.**

5. Evaluation the ability to derive a conclusion using scientific proof and give a proper explanation.

- The results of an experiment examining the work acting to lift a lever are shown in a table.

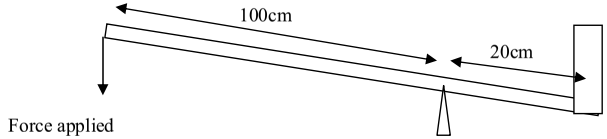
From the table below, what kind of summary (conclusion) could you give? Which is correct?

Weight on fulcrum (newtons)	Distance from fulcrum to effort (m)	Distance from fulcrum to load (m)	Lift of lever with 25N force put on load
10	0.5	0.5	Lowers
20	1.0	1.0	Lowers
30	1.5	1.5	Rises
40	2.0	2.0	Rises

1) The larger the force put upon the effort, the smaller the force put upon the load becomes.
2) The longer the distance from fulcrum to effort, the longer the distance becomes from fulcrum to load.
3) When the amount of **force put upon the effort** x **distance from fulcrum to effort** is bigger than **force acting on the load** x **distance from fulcrum to load**, the load end of the lever will rise.
4) When the amount of **force put upon the effort** x **distance from fulcrum to effort** is bigger than **force acting on the load** x **distance from fulcrum to load**, the load end of the lever will lower.

6. Evaluate ability to understand scientific principles and calculate the answers to problems.

- A pupil has written the length of the arms of a lever.



- The pupil found the following formula in a science book.

(Force applied) x *(distance from fulcrum to where force is applied)* =

(force put on load) x *(distance from the fulcrum to load)*

How much force does the pupil need to apply in order to balance the stick as level and lift up the load of a 50 newton block?

7. Evaluate ability to state the proof in the background of the conclusion and deliberate upon it.

- You have conducted an experiment on the work to lift a lever. You then wrote a summary of the results.

1) If you lengthen the **distance from fulcrum to effort**, the effort end of the lever will lower and the work upon the effort end gets larger.
2) If you make the **force put upon the effort** bigger, the effort end of the lever will lower and the work upon the effort end gets larger.
3) If you shorten the **distance from fulcrum to load**, the effort end of the lever will lower and the work upon the effort end gets larger.
4) If you shorten the **distance from fulcrum to load**, the effort end of the lever will rise and the work upon the effort end gets larger.

After talking over this summary with the pupils, the conclusion is decided as 1), 2) and 3), with 4) being left out. Explain why 4) was not chosen.

Appendix

Examples of materials which is used in Kenyan text books

Push your hand until it just starts to slide.
Can you feel resistance to your push from the desk?
This is the **force** of friction resisting your push.
Now slide your hand about ten times very fast on the desktop.
What happens to your hand?

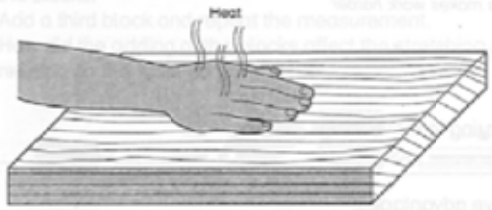


Figure 10.1 *Experimenting with friction*

Now rub your hands together as rapidly as you can. Do you feel resistance?
Touch your cheeks with your hands. Are your hands hot?
The resistance you felt when you rubbed your hands is friction.
The heat is caused by the friction.

▶ ***Friction is the force between two surfaces when they slide over each other. Friction opposes movement.***

(Macmillan; Macmillan Primary Science, Pupil's book 7　P.129)

Activity 1: Observing soles of shoes

- Look for different shoes.
- Observe the soles of these shoes.
- Which soles are smooth?
  Which soles are rough?
- Now look at the soles of shoes shown in the pictures below.

Soles of shoes

(JKF; Primary Science Education Foundation Science 7　P.111)

The soles of the pair of shoes marked B have a good tread. Shoes with a good tread increase the friction between the shoes and the surface on which you are walking. This makes you walk easily without sliding.

Similarly surfaces that are rough, provide friction which enable us to walk with ease. If you walk on a slippery surface, you tend to slide instead of walking. You may fall and hurt yourself. You may also not walk as fast as you wish.

Activity 2: Observing tyres

- Your teacher will show you different tyres.
- Observe the tyres.
- Which tyre is smooth?
- Which tyre has a good tread?
- Look at these tyres below

Tyres

- Which tyre has a good tread?
- Which tyre would have more friction with the road surface?

(JKF; Primary Science Education Foundation Science 7 P.112)

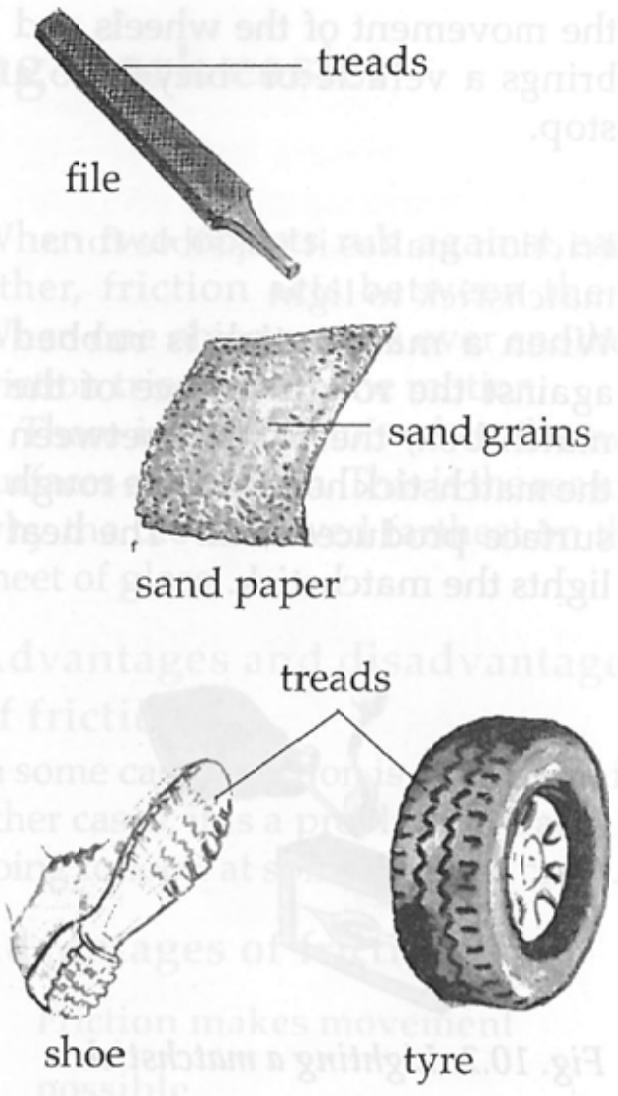


Fig. 10.5: Rough surfaces

(Longhorn; Understanding Science, Pupil's Book 7 P.78)

Lighting matches

Friction makes production of heat possible, for example, in lighting a match.

Writing on the board

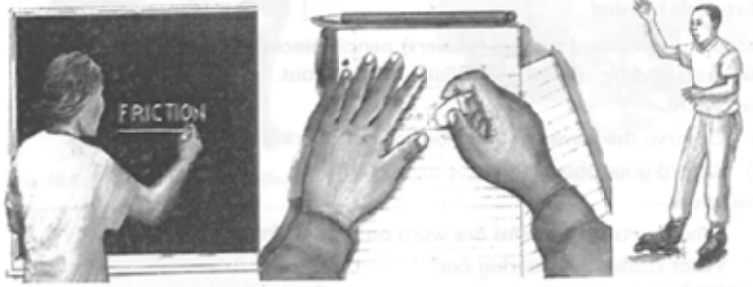
Friction enables one to write on the board. In this case, the force of friction acts between the chalk and the board (see figure 10.6 a).

Rubbing/Erasing

The force of friction acting between the paper and the rubber enables one to erase (see figure 10.6 b).

Skating

The force of friction between the roller skates and the tarmac enables one to skate (see figure 10.6 c).



(a) (b) (c)

(KLB; Primary Science Pupils' Book for Standard Seven P.157)

Advantages and disadvantages of friction

Friction has advantages and disadvantages. This means friction can be useful or harmful (cause unwanted effects).

Advantages

1. Friction is useful in walking because it enables the feet to get a grip onto the ground.
2. When the brakes of a vehicle are applied, the friction between the tyres and the ground slows down the vehicle to enable it to stop.
3. When the brakes of a vehicle are applied, the friction between the wheel and the brake pads makes the vehicle slow down and stop.
4. Friction helps to remove dirt when scrubbing the floor with a brush.
5. Friction lights a matchstick.
6. When we are feeling cold we can rub our hands and feel warm.

Disadvantages

1. Friction makes work harder by opposing movement. For example, pushig a wheelbarrow is very hard due to friction.
2. Parts of machines wear out due to friction, making them inefficient. It is expensive to repair or replace such parts, for example, bicycle tyres.
3. Continued rubbing of clothes during washing leads to wear and tear.
4. Friction causes blisters on our feet and hands when we walk or use tools.

(Oxford; Science in Action 7 P.97)

ACTIVITY

What you need

three identical blocks of wood
force meter or rubber band
drawing pin
string

What to do

Attach some string to the end of one block of wood with a drawing pin.
Pull the block along the desk using the force meter or the rubber band.
Take a reading on the force meter or measure the length of the rubber band as you pull the block.
Add a second block on top of the first and take further readings as you pull the blocks.
Add a third block and repeat the measurement.
How did the adding of the blocks affect the stretching of the rubber band or the reading on the force scale?

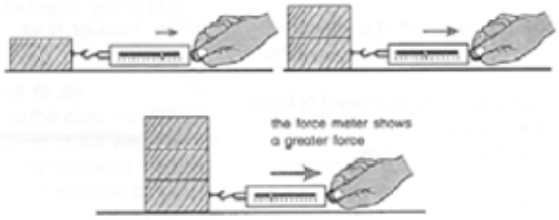


Figure 10.3 Measuring the force

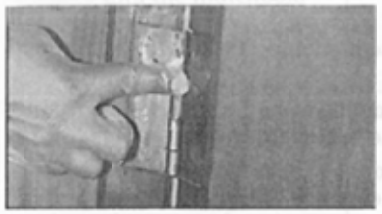
▶ ***The force of friction increases as the force pressing the surfaces together increases.***

(Macmillan; Macmillan Primary Science, Pupil's book 7 P.131)

Reducing friction

Friction must be reduced when its presence causes a disadvantage. This occurs when we want to move objects and prevent wear and tear. Friction can be reduced by:

1. Using **rollers**.
2. **Oiling** and **greasing** moving parts of machines. This is called **lubrication**. Oiling and greasing prevent direct contact between the moving parts of a machine.


door hinge

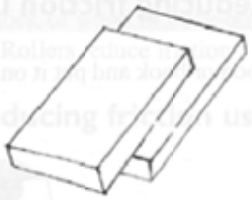

wheelbarrow


bicycle


sewing machine

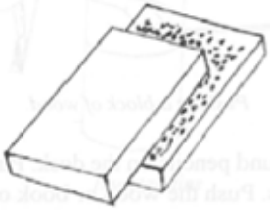
Figure 12.9: Oiling and greasing

(Oxford; Science in Action 7 P.98)



Rubbing surfaces together without oil

- Smear some oil on the surfaces.
- Now rub the smeared surfaces together as shown below.



Rubbing surface with oil together

- What do you notice?
- Which surfaces move over each other easily, the ones without oil or the ones with oil?

(JKF; Primary Science Education Foundation Science 7　P.119)

ACTIVITY

What you need

block of wood with string attached
rubber band or force meter
different surfaces

What to do

Pull the block of wood on different surfaces, taking a reading each time as before.

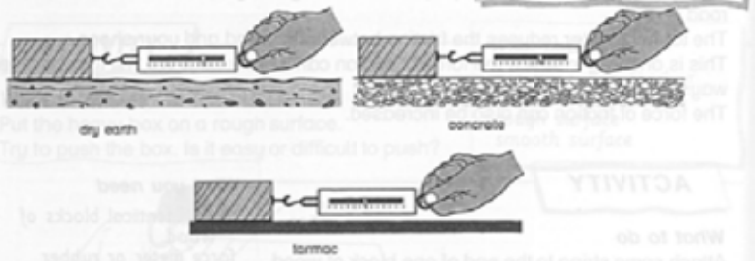


Figure 10.4 *Different surfaces show different frictional forces*

On which surface did the rubber band stretch most/was the reading on the force meter the highest?

▶ ***The force of friction between two surfaces depends upon the types of surfaces used. It increases with rough surfaces.***

(Macmillan; Macmillan Primary Science, Pupil's book 7　P.132)

Activity 2: Reducing friction using rollers

- Take a block of wood or book and put it on your desk. Push the wood or book as shown.

Pushing a block of wood

- Now place three round pencils on the desk. Put your block of wood or book on the pencils. Push the wood or book on the pencils as shown.

Pushing block of wood on pencils

- What do you notice?
- Was it easier to move the block of wood or book with or without the pencils?

(JKF; Primary Science Education Foundation Science 7　P.120)

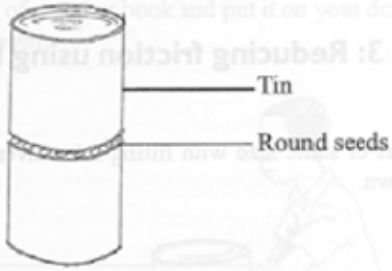
- Find two tins of same size with fitting lids. Invert one tin over the other as shown.

Inverted tins

- Move the upper one round.
- Does it move easily?

(JKF; Primary Science Education Foundation Science 7　P.121)

- Invert the second tin over the tin with seeds.



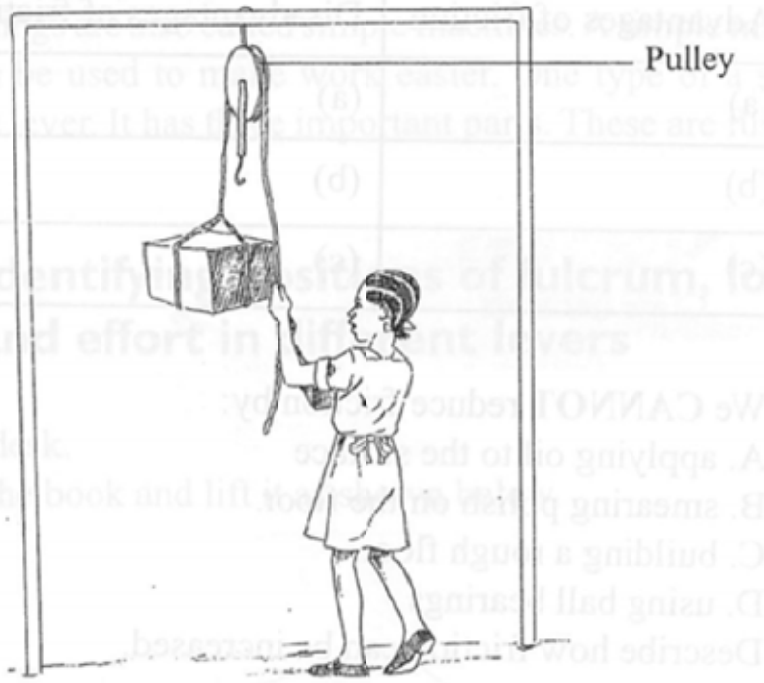
- Turn the upper tin round.
- What do you notice?
- When is it easier to turn the tin, with or without seeds?

It is easier to turn the tin on seeds. This is due to the rolling of the seeds. The seeds act as ball bearings. Ball bearings are put between two moving surfaces. They prevent the surfaces from sliding over one another. Instead, as the ball bearings roll, they make the movement easier. Rolling of ball bearings reduces friction between two surfaces.

(JKF; Primary Science Education Foundation Science 7　P.122)

(JKF; Primary Science Education Foundation Science 7　P.122)

(MAKING WORK EASIER／7th grade)



Using a pulley to lift a weight

(JKF; Primary Science Education Foundation Science 7　P.123)

Streamlining

Solid surfaces that move through air and water can be streamlined to reduce friction. **Streamlining** is giving an object a smooth special shape so that it can move quickly, smoothly and easily through air, water or any other gas or liquid. Study the two shapes shown in figure 10.11 and make notes on them. Shape B would move more easily, smoothly and quickly in a horizontal direction than shape A.

Fig. 10.11: Shape B is streamlined; it can move more quickly, smoothly and easily through air

(Kenya Literature Bureau, Primary Science Pupils' Book for Standard Seven, P.161)

. Using streamlined shapes such as canoes and an aeroplanes. This reduces the air or water resistance.

Figure 12.11: Streamlined canoe

(Oxford; Science in Action 7 P.99)

Unit Summary and Important Terms

- Friction can be defined as the force that opposes the movement of one surface over another.
- The force of friction is useful.
  - Friction enables one to walk. The force of friction acting between the feet and the ground enables one to walk. If there were no friction force, it would be impossible to walk.
  - Friction makes movement of vehicles possible. The tyres of vehicles have patterns cut into them called treads to make them have rough surface. The friction between the tyre and the road allows easy movement of the vehicle.
  - When the brakes of vehicles and bicycles are applied, the brake pads press hard on the wheels and produce friction. It is this friction that stops the wheels from rotating.
  - The force of friction makes it possible to light a match.
  - The force of friction enables one to write on the board.
  - The force of friction acting between the paper and the rubber enables one to erase.
  - The force of friction enables one to roller skate.
- The force of friction is, sometimes, a nuisance.
  - Car tyres, bicycle tyres and soles of shoes wear out because of friction between them and the ground.
  - The collars of shirts and blouses wear out because of the friction between them and the body. They also get exposed to friction during washing.
  - Rubbers, pencils and pieces of chalk wear out as a result of friction.
  - When one is pushing or pulling a heavy log on a rough ground, friction makes the pulling or pushing very difficult.
  - When friction acts between moving parts of machines and vehicles, these parts wear out. If the worn-out parts are not replaced, they can cause an accident.
- Some ways of reducing friction include:
  - Using rollers and ball bearings
  - Smoothening/ polishing surfaces
  - Using lubricants
  - Streamlining
- You can increase friction by making surfaces rough.

(KLB; Primary Science Pupils' Book for Standard Seven PP.170-171)

A lever has the following parts:

- load
- fulcrum
- effort

The big stone is the load

The turning point between the rod and the small stone is called **fulcrum** or **pivot**.

The force that we apply to push the stone is called **effort**.

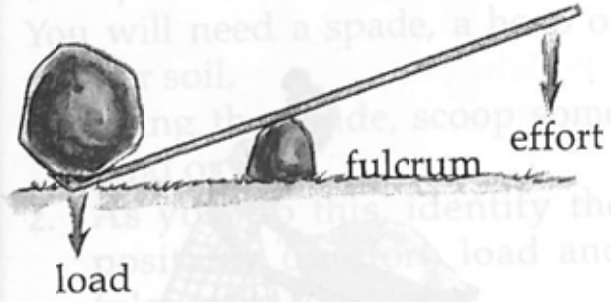


Fig. 10.11: Position of fulcrum, load and effort

(Longhorn, Understanding Science, Pupil's Book 7 P.81)

The diagram shows these positions.

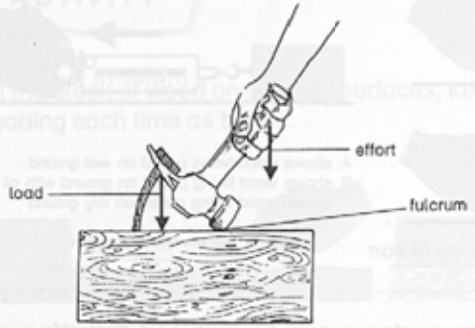


Figure 10.6 *Identifying the positions of fulcrum, load and effort in a claw hammer*

(Macmillan; Macmillan Primary Science, Pupil's book 7 P.134)

- Identify the positions of the fulcrum, load and effort.

(Longhorn; Understanding Science, Pupil's Book 7 P.82)

The effort is between fulcrum and load.
The arrangement is as shown below.

Fig. 10.16: The position of load, effort and fulcrum when a spade is in use.

(Longhorn; Understanding Science, Pupil's Book 7 P.83)

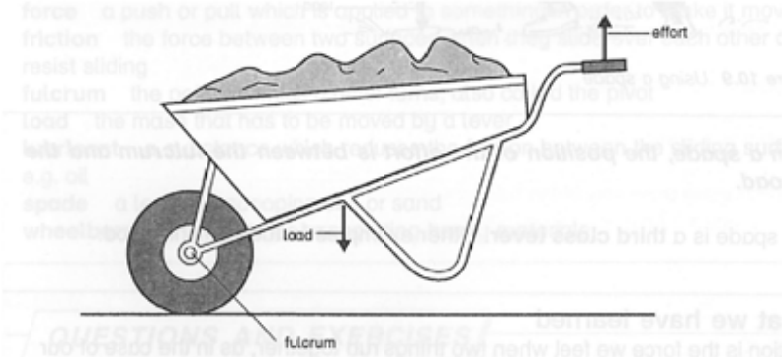


Figure 10.8 A wheelbarrow in use

▶ ***In a wheelbarrow, the load is found between the effort and the fulcrum.***

(Macmillan; Macmillan Primary Science, Pupil's book 7 P.135)

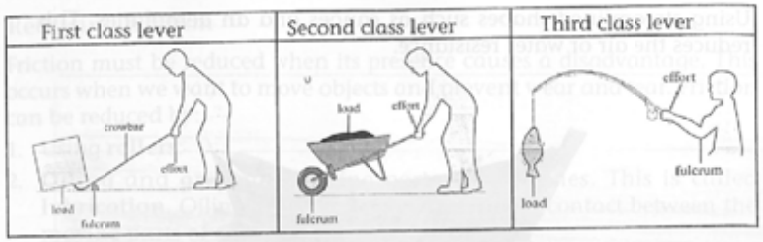


Figure 12.13: The classes of levers

Common levers

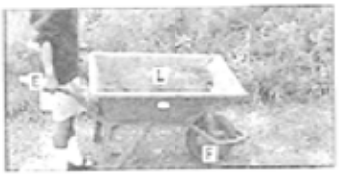
claw hammer

a pair of scissors

Figure 12.14: Examples of first class levers

(Oxford; Science in Action 7 P.100)

The fulcrum is between the load and the effort. These are first class levers.



wheelbarrow

garlic crusher

Figure 12.15 Examples of second class levers

The load is between the effort and fulcrum. These are second class levers.

spade

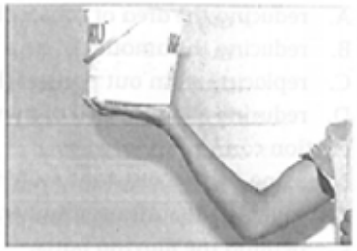
tongs

Figure 12.16: Examples of third class levers

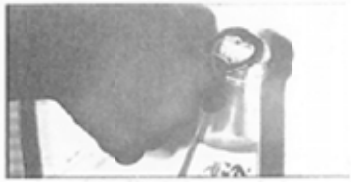
The effort is between the load and the fulcrum. These are third class levers.

Other levers are shown below.

fishing rod



human arm



bottle opener

weighing balance

rowing oar

a pair of pliers

Figure 12.17: Commonly used levers

(Oxford; Science in Action 7　PP.100-101)

Lever	Arrangement of the load, effort and fulcrum	Other examples	Class of levers
Crowbar	Load – Fulcrum – effort	sea-saw, pliers, weighing scales	1st Class
Wheelbarrow	Fulcrum – Load – effort	nut crackers, bottle opener	2nd Class
Spade	Load – effort – fulcrum	fishing rod	3rd Class

(Longhorn; Understanding Science, Pupil's Book 7　P.83)

Do you remember these new words?

claw hammer　a lever used for removing nails
crowbar　a plank of wood or metal used for lifting a heavy load
effort　the force put into a lever to move the load
force　a push or pull which is applied to something in order to make it move
friction　the force between two surfaces when they slide over each other or resist sliding
fulcrum　the point at which a lever turns; also called the pivot
load　the mass that has to be moved by a lever
lubricant　a substance which reduces the friction between the sliding surfaces, e.g. oil
spade　a lever for scooping soil or sand
wheelbarrow　a lever for transporting heavy materials

(Macmillan; Macmillan Primary Science, Pupil's book 7　P.137)