Force

A force is the pull, push or a lift on an object.

Force is measured in Newtons using a spring balance

Effect of force on an object

(i) It makes stationary object move
(ii) It makes a moving object to stop or increase speed
(iii) It changes the direction of a moving object
(iv) It changes the shape of an object.

Types of force

(i) Weight
(ii) Gravity
(iii) Friction
(iv) Magnetic

Weight

Is the amount of force of gravity acting on an object. Weight may vary from one place to another depending of acceleration due gravity

Gravity

Is the force that pulls thngs towards the center of the earth. Forinstance stones through up fall due to gravity.

Inertia is a property of matter that causes it to resist changes in velocity. Either an object remain at rest or continue with constant velocity.

Friction

This is a force that oppose motion or movement

Advantages of friction

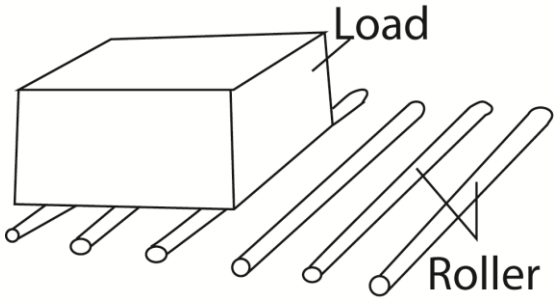
- Prevents us from falling while walking
- Enables us to write with a pencil or a pen
- Enable us to use a rubber to eraze
- Cause heat between match box and match stick leading to lighting of match stick

Disadvantage of friction

- wears out shoe, tyres, machines
- produces unnecessary sound
- produces unnecessary heat
- increases effort required to move
- causes blisters on hands

Methods of reducing friction

- oiling
- using ball bearing
- using rollers



- smoothening surface
- making objects streamline like boat or aeroplane

Ways of increasing friction

- making surfaces rough e.g. tarmaking road.
- Having no air trapped between surfaces

Machines

A machine is a device that makes work easier.

In machines an effort (force in neuton) is applied to move the load.

The effort can be

Muscular effort from man or

Force derived from an engine.

Principle of simple machines

The principle used in a simple machine is to produce a big force over a small distance by using a small force over large distance.

The force which we apply to the machine is know as **effort** (**E**) and the load we have to overcome is is known as the **load (L)**. Both force and load are measured in Newton.

Types of machines

1. Simple machnes
2. Complex machine

Simple machines

These are devices that work with one movement and change the size and direction of force.

Examples of simple machnes include levers, pulley, hydraulic, gears, screws, and inclined planes

Levers

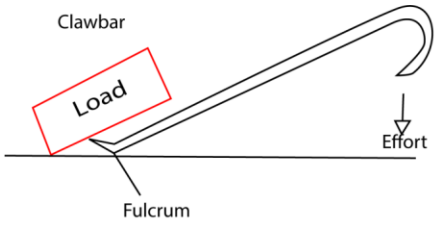
A lever is a rigid bar which is free to move about a fixed point, the Fulcrum or povot

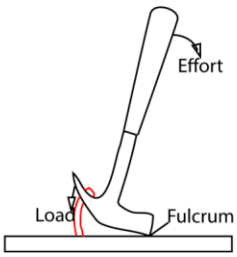
Levers are divided into three classes

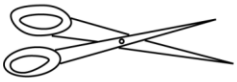
(i) The first class levers
(ii) The second class lever and,
(iii) Third class levers

(a) First class lever

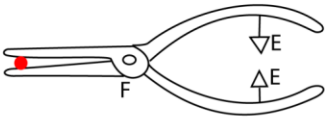
This is a type of lever in which the fulcrum is between the effort and the load.
Examples of first class lever include Craw bar, scissor, beam balance, scissor and pair of pliers,



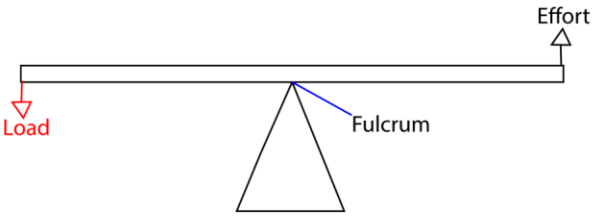




Pair of scissors



Pair of pliers



Beam balance

The Principle of Moments

States that when a body is balanced, the total clockwise moment about a point equals the total anticlockwise moment about the same point.

Equation

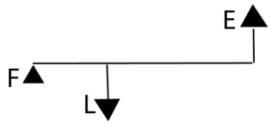
Moment =force F x perpendicular distance from the pivot d.

Moment = Fd

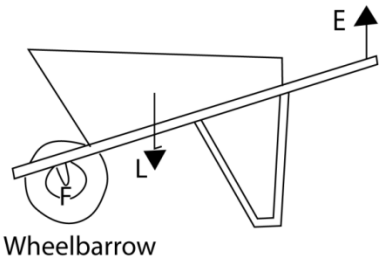
(b) Second class lever

Here the load is between the effort and fulcrum.

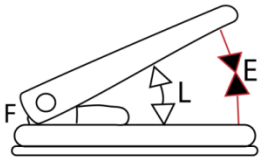
Examples are wheelbarrow, nut cracker and office punch



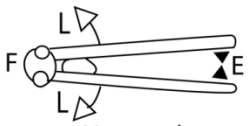
Second class lever in general



Wheelbarrow



Office punch

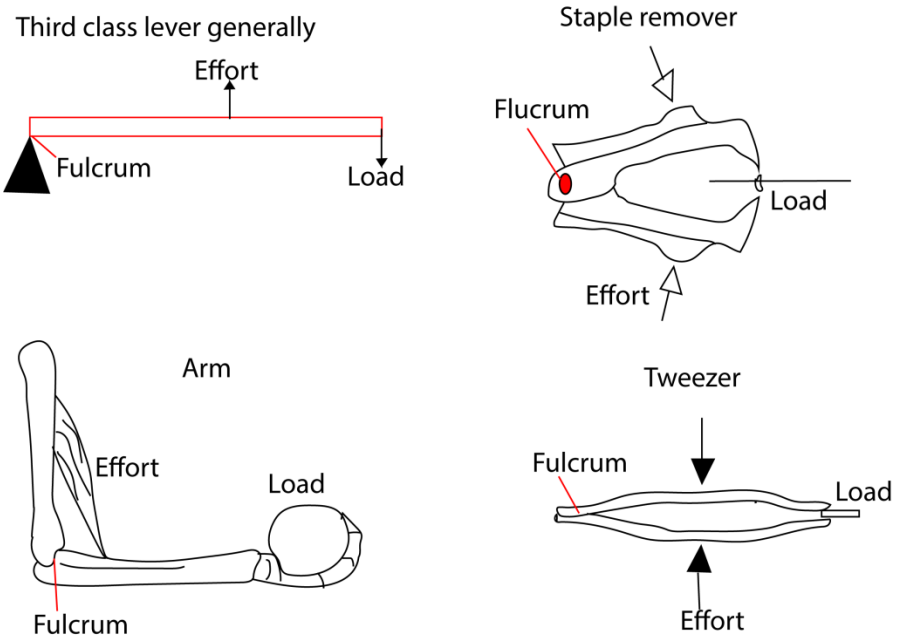


Nut cracker

(c) Third class lever

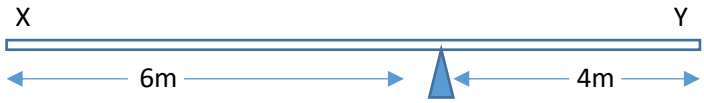
Here the effort isf between the load and fulcrum.

Examples are wheelbarrow, nut cracker and office punch



Example

In the diagram below Isaac and Susan sit on seesaw above, such that Isaac sits at point X and Susan at point Y. Find the mass of Isaac if Susan weighs 45kg.



Principle: clockwise moment = anticlockwise moment.

Let the mass of Isaac be M

Taking moments at the fulcrum

Clockwise moment = 4 x 45 = 180gm

Anticlockwise moment = M x 6 =180gm

$$\mathbf{M = \frac{180}{6} = 30kg}$$

Therefore, Isaac weighs 30kg

Mechanical advantage (M.A)

This is the ratio between the load and the effort applied.

i.e $M.A = \frac{Load\ (L)}{Effort\ (E)}$

Significance of mechanical advantage

The bigger the mechanical advantage the better the machine since small effort can lift a bigger load.

Velocity ratio

This is the ratio of distance moved by effort over the distance moved by the load

i.e. Velocity ratio (V.R) = $\frac{distance\ moved\ by\ effort}{distance\ moved\ by\ load}$

Velocity ratio has no units

Significance of velocity ratio

The bigger the velocity ratio the less effort required to do work and the more efficient the machine. Or the machines requires less effort to overcome a big load when effort moves a bigger distance compared to the load in a uinit time.

Example 1

A load of 100N is raised through 6m when an effort of 40N moves through 24m. Calculate

(i) mechanical advantage

(ii) velocity ratio

Solution

(i) $M.A = \frac{Load\ (L)}{Effort\ (E)} = \frac{100}{40} = 2.5$

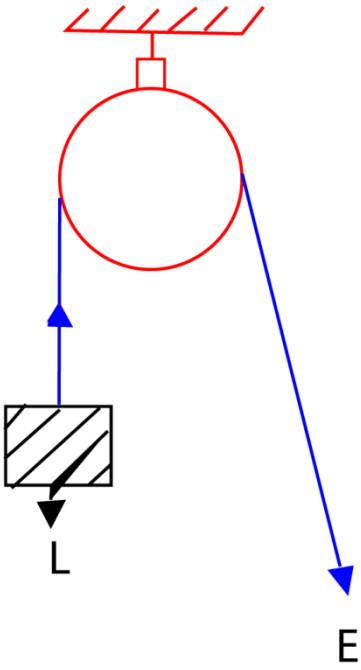
(ii) Velocity ratio (V.R) = $\frac{distance\ moved\ by\ effort}{distance\ moved\ by\ load} = \frac{24}{6} = 4$

Pulleys

A pulley is a wheel with a groove ring which passes or string .

- The effort is applied to one end of the rope and the disk of the pulley rotate as the rope moves over it
- If there are several pulleys in a frame work, it is called a block

Single fixed Pulley

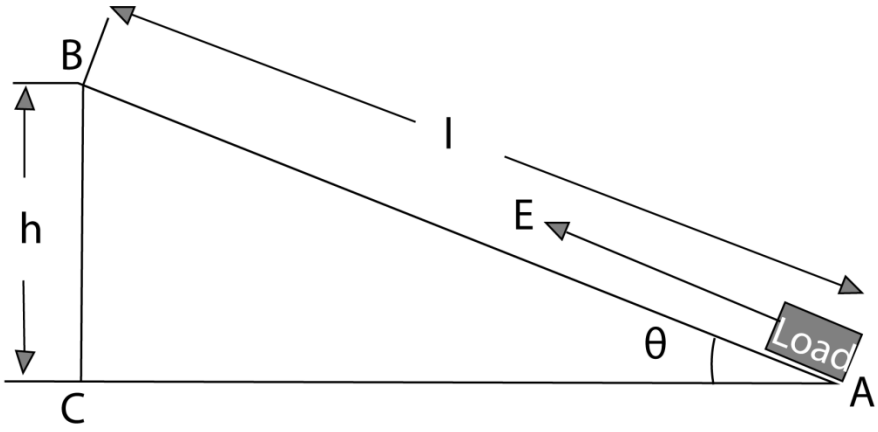


Application of single pulley system

- Removing water from a well
- Lifting building material in the site
- Used on a flag post in the school
- Used at the port to load and unload ship

Inclined Plane

This refers to a type of a machine in which a plane is inclined to an angle to the horizontal such that one end is higher than the other by angle, Θ.



- it used to lift heavy load by pulling/pushing it along the sloping surface.
- It is easier to carry the load along the slope than lifting it through the vertical height, h, since the weight of the load acts vertically downwards (and only a component of weight acts along the plane)
- In order to raise the load through a vertical height, h, th effort, E is applied through a longer distance, l, equal to the length of the plane.

Examples of inclined plane include

(i) Slopping roads
(ii) Stair case
(iii) Winding road

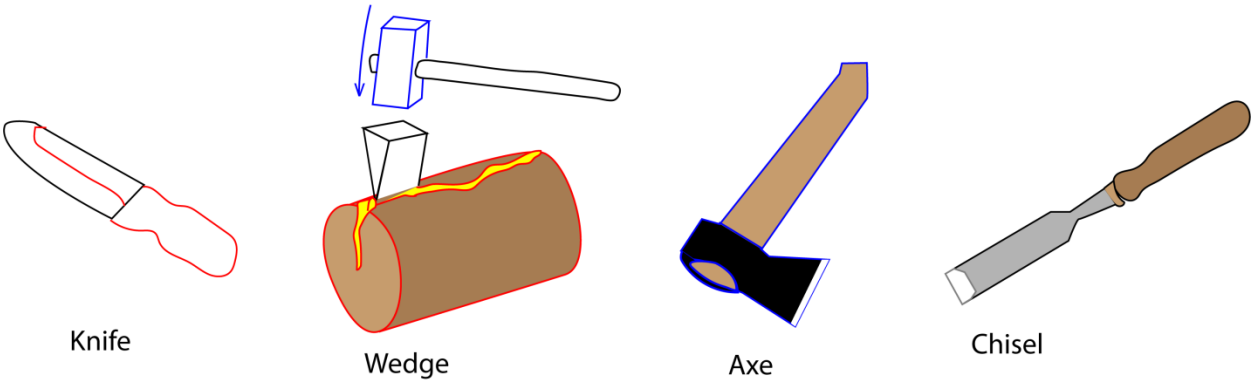
The Wedges

The wedge is a kind of simple machine which is an inclined plane having one or two sloping sides. With a wedge, the sloping surface is pushed through the material which is held still.

Examples of wedges are: Knife, axe, chisel, needle, nail, razor blade

Uses of wedges include: Cutting, pitching

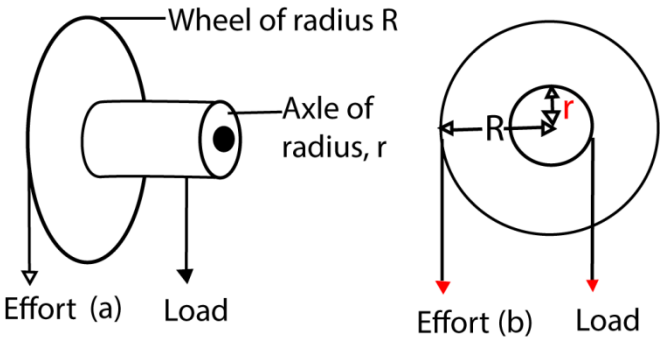
Examples of wedges



Wheel and axle

A wheel and axle is a type of simple machine made up of a wheel and axles rigidly attached to each other so that they turn together about an axis.

The effort is applied to the larger wheel and the load is raised by string attached to the axle of small diameter as show below:

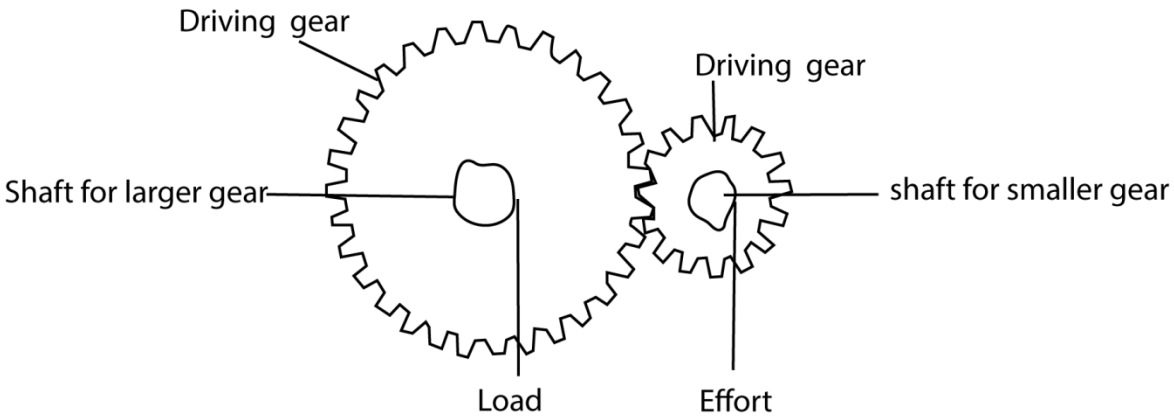


Uses of wheel and axle

(i) The car steering wheel
(ii) Screw driver
(iii) Windlass (used to raise a heavy bucket of water in a well.

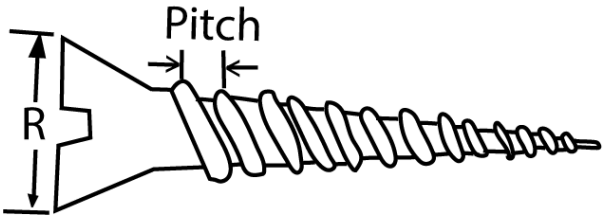
Gears

A gear is a device which consists of a set of toothed wheels. Gears change the direction and speed of rotation. They are similar to wheel and axle. In gear wheel, the effort and the load are applied to the shafts connected to gear.



The screw

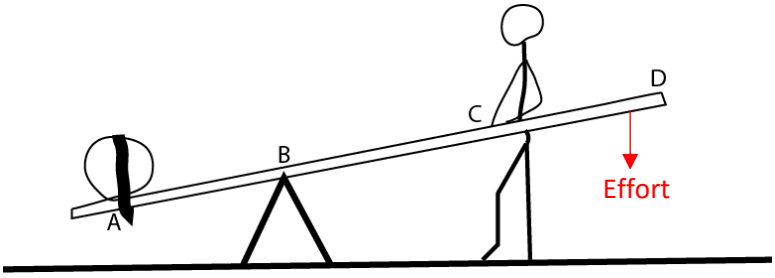
A screw may be considered as continuous inclined plane wound round a cylindrical threaded rod.



- The distance between two successive threads is called a pitch

Sample questions and answers

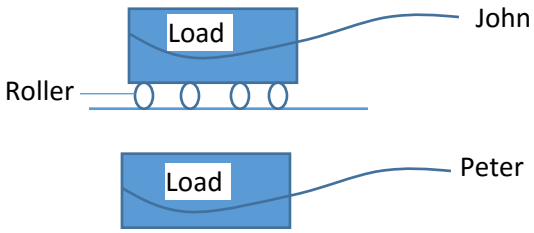
The diagram blow shows a man using a pole for lifting a piece of stone. Use it to answer questions 1 and 2.



1. On the diagram, show the direction of the effort.
2. What should the man do to lift the load more easily?

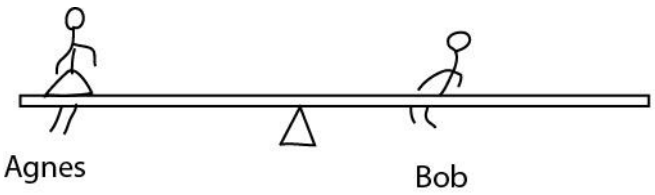
   He should apply effort on position D to make work easier.

3. Bbosa pulls a load of 50kg over a set of metal rollers. Peter pulls another load of the same weight along the ground (see diagram below)



   (a) Explain why one of the two (people) uses less force.
   John uses less force because the rollers minimize friction at the surface
   (b) What is the advantage of a driver pouring sand on a slippery road.
   To increase friction to facilitate movement.
   (c) Explain your answer in (b) above?
   Sand makes slippery road rough which increases friction

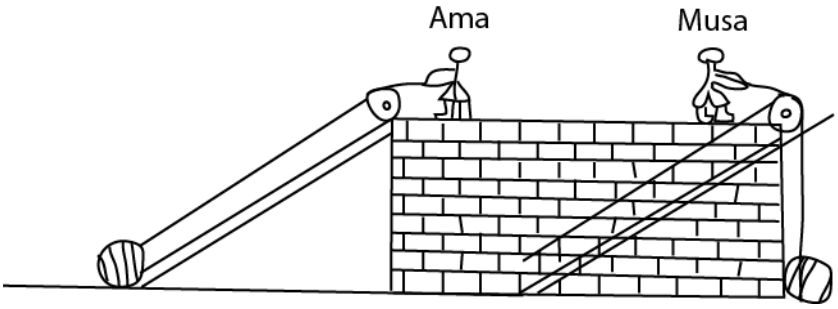
4. Bob and Agnes are sitting, balanced, on a seesaw as shown in the diagram below.



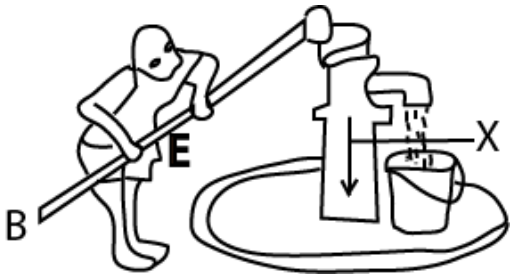
   How does the diagram show that Bob is heavier?

   Bob balances Agnes who sits further from the fulcrum

The diagram below shows two boys. Musa and Juma pulling pieces of wood of equal weight up the wall. Use it to answer questions 5 and 6.

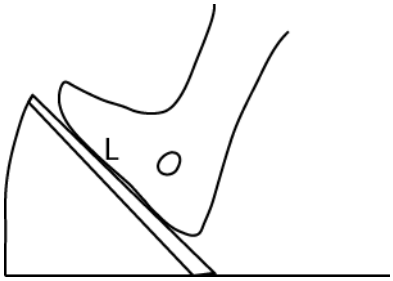


5. Which boy uses less force to pull wood?
   Ama
6. Explain your answer to question 33 above.
   Inclined plane reduced the effort required
7. The diagram below shows a boy collecting water from a water pump. Use it to answer the questions that follow.

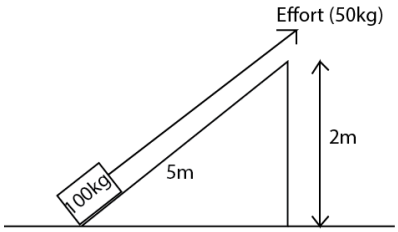


   (a) Mark on the diagram with letter E the position of the effort.
   (b) What does the part marked X represent?
   Atmospheric pressure
   (c) What change would the boy experience if he moved the hands to position B?
   He would uses less effort to pump water
   (d) If the effort is 20, and the load is 80, what is the mechanical advantage of the pump?
   Mechanical advantage = $\frac{load}{effort} = \frac{80}{20} = 4$

8. When drawing water from a borehole, why is the handle led far from the fulcrum?
   To use less effort
9. The diagram above shows the foot of a driver accelerating the car. Indicate on it with letter L, the position of the load



10. The diagram below shows a machine used to lift a load using an effort of 50kg

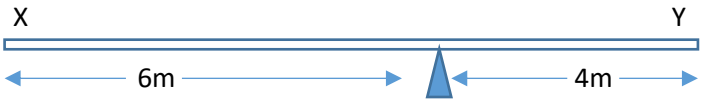


(a) Name the machine.
Inclined plane

(b) What distance does the load and effort move through?
Load moves 2m while effort 5m

(c) How can you use less than 50kg to pull the load?
Reduce the angle of inclination

Use the diagram below to answer question 11.



11. Isaac who weighs 30kg and Susan who weight 45kg sit on seesaw above, such that Isaac sits at point X and Susan at point Y. which side of the seesaw go down?

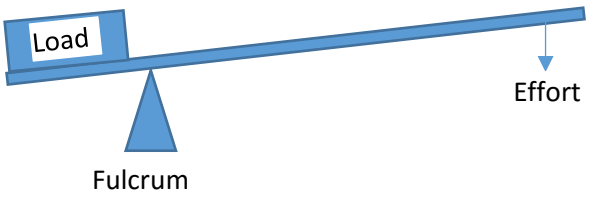
Taking moments at the fulcrum

Clockwise moment = 4 x 45 = 180gm

Anticlockwise moment = 30 x 6 =180gm

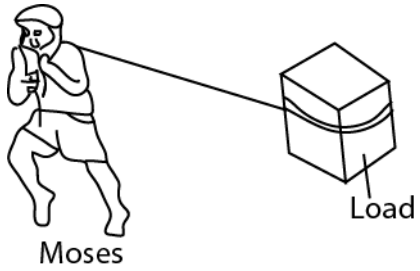
Since clockwise moment = anticlockwise moment, the seesaw balances.

12. In the diagram below, what class of lever is represented?



First class lever.

13. In the diagram, Moses is pulling a load the ground surface, as shown below.



How could Moses make his work easier?

By using rollers

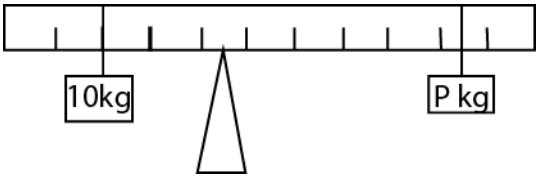
14. In terms of machines, how is the hammer similar to the human arm?

Both make work easy

15. How do road builders increase friction on the surface of the road?

By adding sand or tarmacking

The diagram below shows a lever which is balanced. Use it to answer question 16.



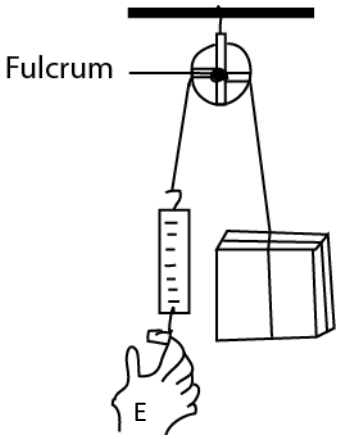
16. The diagram shows a lever which is balanced, calculate the weight of **P.**

Clockwise moment = anticlockwise moment

P x 5 = 10 x $\frac{5}{2}$

P = 5kg

17. Use the diagram of the machine below to answer the question that follow.



(a) What is the name of such a machine?

Pulley

(b) What class is it?

First class lever

(c) Use letter E to show effort on the diagram.

(d) Which important activity in school is done using this machine?

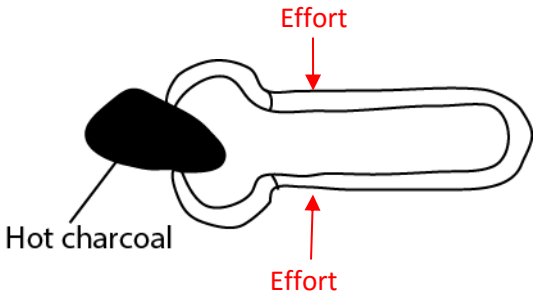
Digging pit latrine, digging underground well

18. Apart from using more energy, name one other disadvantage of friction.

Wears out surfaces

Creates unnecessary heat

The diagram below is of a simple machine. Use it to answer questions 19 and 20



19. Indicate with letter E the position of the effort.
20. What class of lever is this machine?

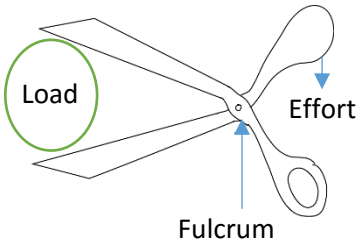
Third class level

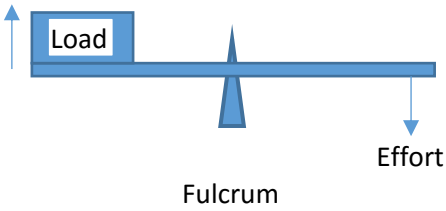
21. Why do tyres of cars wear out more quickly on tarmac roads than marram roads?

Tarmac roads have high friction than marram roads

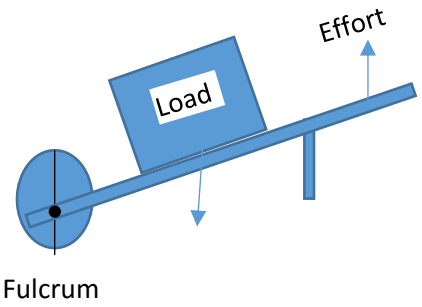
22. Show the difference between the first-class lever and the second –class lever by drawing and labeling the two diagrams.
The first class lever, the fulcrum is between the load and effort while in second class lever, the load is between the fulcrum and effort.

(a) First –class lever





(b) Second –class lever

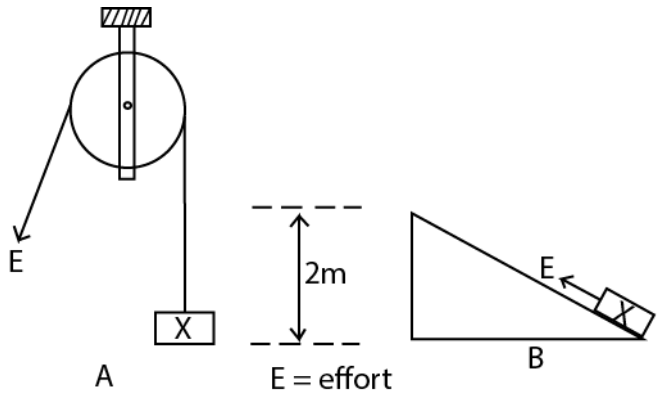


23. Peter uses a wheel barrow to carry potatoes from his garden to the market. What is the advantage of using such a machine?

Less effort is required

24. The diagram bellow show two types of simple machines labelled a and b

Use it to answer the questions that follow.



(a) Name each of the machines shown in the diagram

(i) **A**: **single fixed pulley**

(ii) **B**: **inclined plane**

(b) Which of the two machines would you choose to use to lift the load **X** to a height of two metres?

P**ulley**

(c) Give a reason for your choice of machine in (b) above.

Uses less effort

25. Give any one form of energy produced when a carpenter driver drives a nail into a piece of wood a harmer.

Sound energy

Heat energy

The diagram below shows a simple lever system

Use it to answer question 26, 27 and 28.

26. Show on the diagram, with an arrow, the direction of movement of the effort at P as load is being lifted.
27. At which of the two points D and P shown on the diagram will less effort be used to lifted the load?

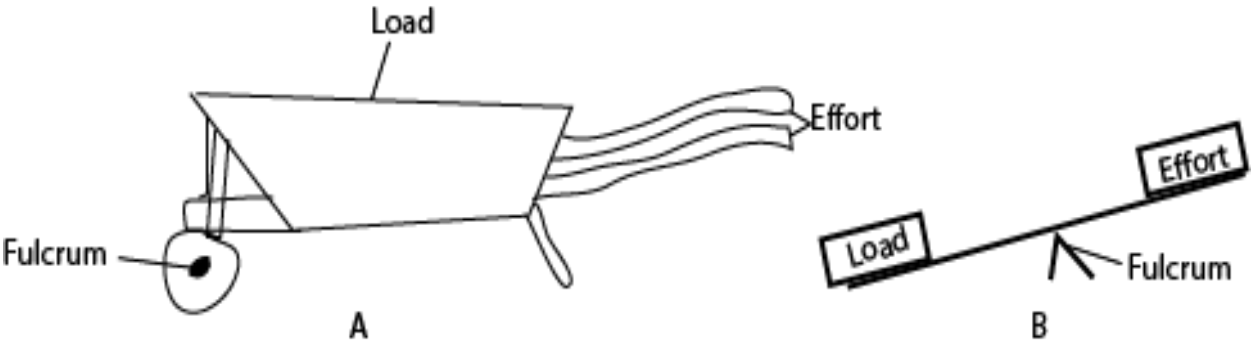
At P

28. Give a reason for your answer in 38 above.

It is far from the pivot.

29. The diagram below shows two simple machines

Use it to answer the question that follow



(a) Name the machine marked with the letter **A**

Wheel burrow

(b) State the class of lever to which each of the above machines belongs:

(i) machine **A**: **second class lever**

(ii) machine **B**: **first class lever**

(c) Give any one example of a machine which works in the same way as the machine marked with letter **B**

Pair of scissor

Priers

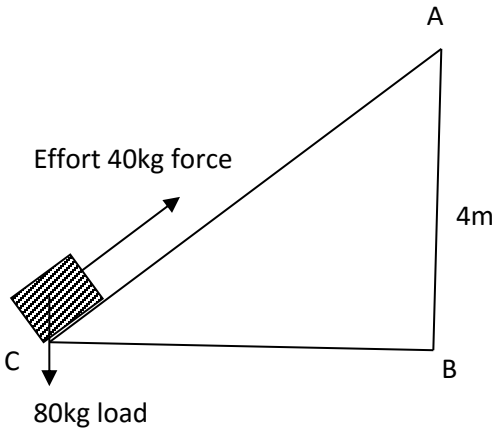
30. Give any one form of energy that is produced during the process of splitting firewood with an axe?

Heat energy

Sound energy

31. The diagram below shows a machine used for lifting loads

Use it to answer the question that follow.



(a) What distance is the load to be lifted?

4m high

(b) Give the advantage of lifting the load alongside **CA.**

Less effort is used to make work easier

(c) Find the mechanical advantage of the machine above.

$$\textbf{MA} = \frac{Load}{Effort} = \frac{80}{40} = \mathbf{2}$$

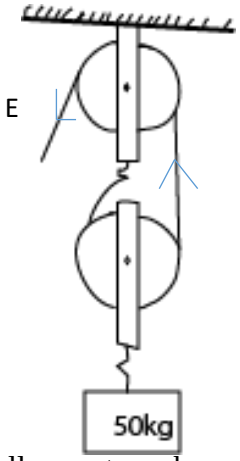
(d) How can the machine be improved so that less effort is used to lift loads.

By reducing the angle of inclination of the plane

32. Whenever peter opens or closes his door, the hinges makes noise. What can he do to stop the noise when he is opening?

Oiling the hinge to reduce friction

33. 49. The diagram below is of a pulley system. Use *it use to answer questions that follow.*



(a) Name the types of pulley system shown above

Block and tackle pulley system

(b) Use an arrow to show the direction of effort.

(c) If the mechanical advantage of the machine is 2 and the load being carried by the machine is 50kg. Find the effort needed to raise that load.

$$\text{MA} = \frac{L}{E} = \frac{50}{E} = 2$$

$$\text{E} = \frac{50}{2} = 25kg$$

E = 25 x 10 = 250N

34. Name the class of simple machines to which an axe belongs.

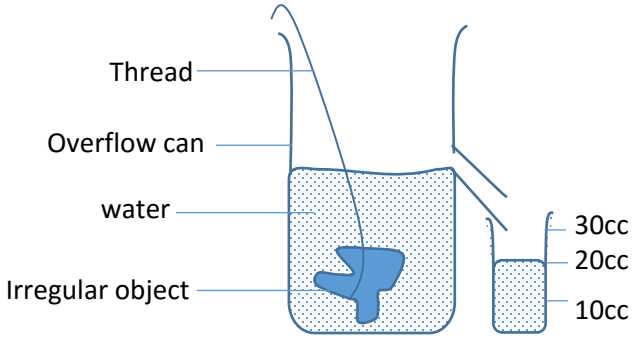
Wedge

35. Name the turning point of a machine.

Fulcrum

36. State any one way in which friction in moving parts of a machine can be reduced.
    - **By oiling**
    - **By greasing**
    - **by using roller**
    - **By using ball bearings**

37. An irregular object was lowered into an overflow can **A** containing water. The water it displaced was collected in container **B** as shown below.



(a) What is the volume of the irregular object?

$20cm^3$

(b) Calculate the density of the irregular object if its mass is 60 g

Density = $\frac{mass}{volume} = \frac{60}{20} = 3gcm^{-3}$

38. To which class of levers does a wheel barrow belong?

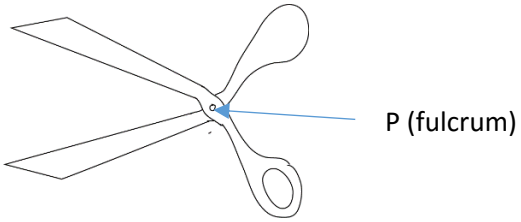
Second class lever.

39. State the difference in units to measure weight and mass.

Mass is measured in kilogram (kg) whereas weight is measured in Newton (N)

The diagram below shows a simple machine

Use it to answer questions 40 and 41



40. To which class of levers does the machine above belong?

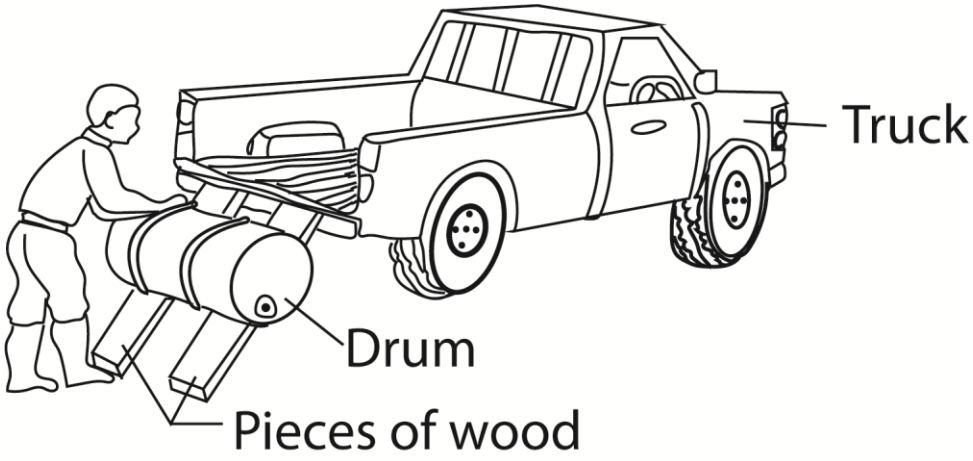
First class lever

41. Put letter P if the position of fulcrum

42. Give one reason why less effort is applied to move a load using first class levers.

The effort is applied further from the fulcrum than the load

43. The diagram below shows a man using a simple machine to load a drum on to a truck. Study and use it to answer the questions that follow



(a) What type of simple machine is the man using?

Inclined plane

(b) Give any two examples of the type of simple machines you named in (a) above

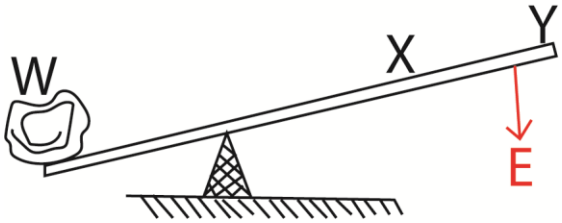
(i) Ladder

(ii) Inclined load

(c) How can the man improve on the simple machine above in order to make his work easier?

Make piece of wood long to reduce the inclination

The diagram below is of a crow bar. Study and use it to answer questions 44 and 45



44. Which of the two positions X and Y requires less effort to overcome the load W?

At Y

45. Indicate on the diagram with an arrow E, the direction of the effort used to overcome the load W.