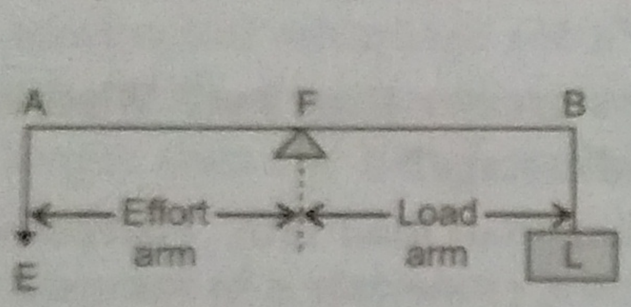
130. Give the examples for different classes of levers.

Ans. Classes of levers:

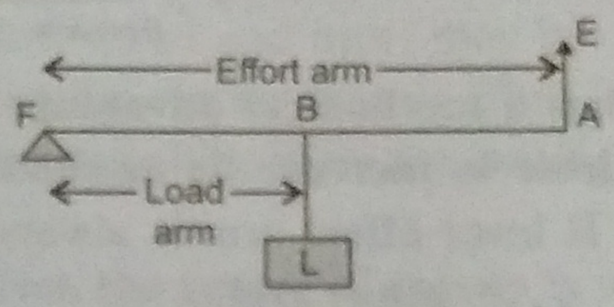
I	II	III
(*i*) Crowbar (*ii*) A claw hammer (*iii*) Handle of handpump (*iv*) A seesaw (*v*) Scissors (*vi*) Pliers (*vii*) The beam of a common balance (*viii*) A car jack	(*i*) A wheelbarrow (*ii*) Oar of boat (*iii*) A nutcracker (*iv*) Lock and key system (*v*) Lemon squeezer (*vi*) Sugarcane cutter (*vii*) Hinges of a door (*viii*) Bottle opener (*ix*) Bar to lift load	(*i*) Bread knife (*ii*) The human forearm (*iii*) Fire tongs (*iv*) A spade (*v*) A fishing rod (*vi*) Forceps (*vii*) A swimmer moving his hands in water (*viii*) A person writing on a piece of paper (*ix*) Hair plucker (*x*) Foot treadle

131. How do you define a lever? Give diagrammatic representation of different types of levers.

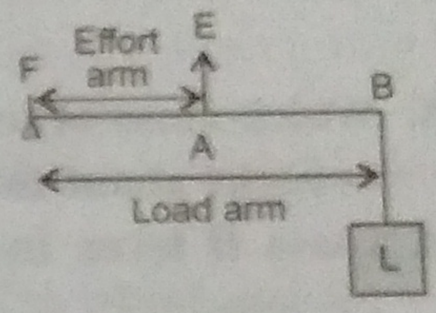
Ans. Lever is a rigid, straight or bent bar which is capable of turning about a fixed turning point or an axis (called fulcrum). Depending upon the relative positions of the load, effort and fulcrum, levers can be represented by the following figures.



Class I lever



Class II lever



Class III lever

132. With reference to their direction of action, how does a centripetal force differ from a centrifugal force? **[2013]**

Ans. Centripetal force is a force directed towards the centre of circle at each point, while centrifugal force is a pseudo force acting away from the centre of the circular path.

133. Which class of lever found in the human body is being used by a boy

(*a*) when he holds a load on the palm of his hand?

(*b*) when he raises the weight of his body on his toes? **[2013]**

Ans. (*a*) Class III lever (*b*) Class II lever

134. Draw a simplified diagram of a lemon crusher, indicating direction of load and effort. **[2015]**

Ans. Lemon crusher.

135. (*a*) Why is the mechanical advantage of a lever of the second order always greater than one?

(*b*) Name the type of single pulley that has a mechanical advantage greater than one. **[2010]**

Ans. (*a*) The mechanical advantage of a lever of the second order is always greater than one because effort arm is greater than load arm.

(*b*) Single movable pulley has a mechanical advantage greater than one.

136. (*a*) With reference to the terms mechanical advantage, velocity ratio and efficiency of a machine name the term that will not change for a machine of a given design.

(*b*) Define the term stated by you in part (*a*).

Ans. (*a*) Velocity ratio.

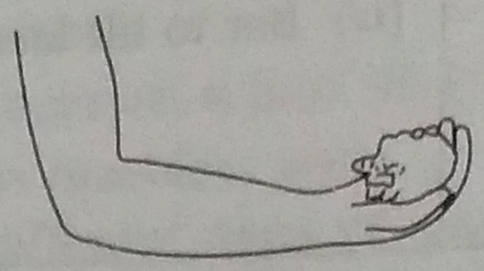
(*b*) The velocity ratio of a machine is defined as the ratio of velocity of the effort to the velocity of the load.

$$\text{Velocity Ratio } (VR) = \frac{\text{Velocity of effort } (V_E)}{\text{Velocity of load } (V_L)}$$

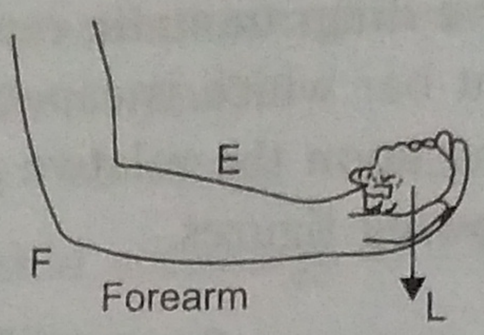
If V_E and V_L are the velocities and d_E and d_L are the displacements of the effort and load respectively acting for a time t then

$$VR = \frac{(d_E/t)}{(d_L/t)} = \frac{d_E}{d_L}$$

137. Copy the diagram of the forearm given below, indicate the positions of Load, Effort and Fulcrum.



Ans.



138. Which class of levers has a mechanical advantage always greater than one? What change can be brought about in this lever to increase its mechanical advantage?

Ans. Class II lever. In class II lever effort arm is always greater than load arm. Therefore,

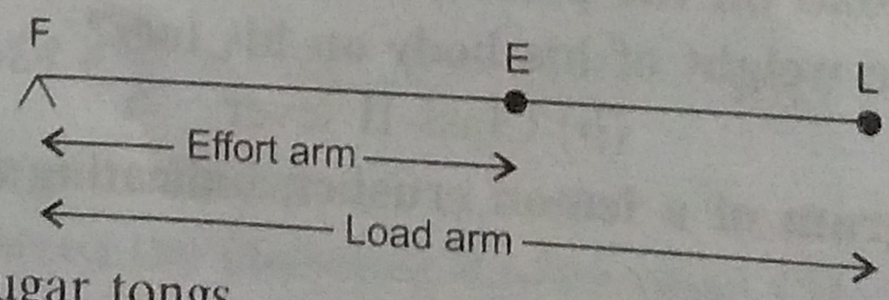
Mechanical Advantage, $MA = \frac{\text{effort arm}}{\text{load arm}}$ is always greater than one.

To increase its mechanical advantage, decrease its load arm.

139. Which class of levers has a mechanical advantage always less than one? Explain briefly with a diagram why their mechanical advantage is less than one.

Ans. We know that Mechanical advantage = effort arm/load arm.

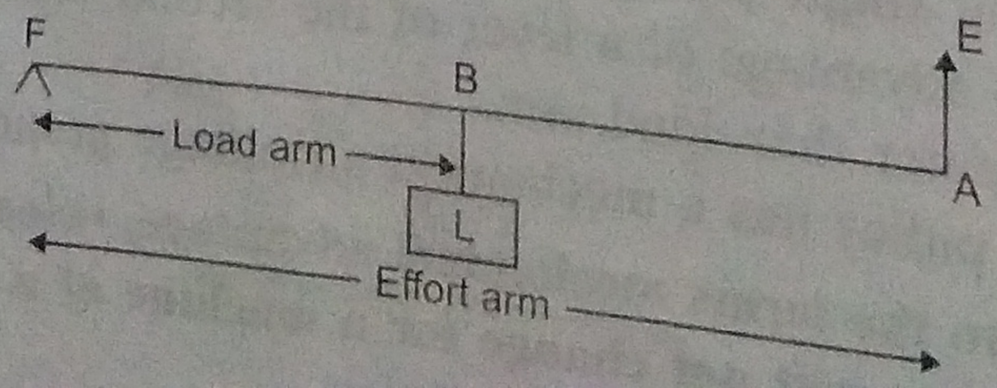
In third class of levers, effort arm is always less than load arm, therefore mechanical advantage is always less than 1.



Example of class III lever is sugar tongs.

140. To use a machine as a force multiplier, what type (class) of lever should preferably be used? Draw a sketch of such a lever.

Ans. Lever of class II is used as a force multiplier. In such a lever, effort arm is always longer than the load arm so its mechanical advantage is always greater than one, i.e. by applying less effort, large load is lifted.



141. A pair of scissors and a pair of pliers belong to the same class of levers.
(a) Which one has mechanical advantage less than one?
(b) State the usefulness of a machine whose mechanical advantage is less than one.

Ans. (a) A pair of scissors and a pair of pliers both belong to class I levers.
In class I levers $MA >, =, < 1$.

$$\text{Mechanical Advantage} = \frac{\text{Load } (L)}{\text{Effort } (E)} = \frac{\text{Effort arm}}{\text{Load arm}}$$

In a pair of scissors, effort arm is less than the load arm.
Mechanical advantage of a pair of scissors is less than one.

(b) The machines with $MA < 1$ help us to apply the effort at a more convenient point or to gain in speed.

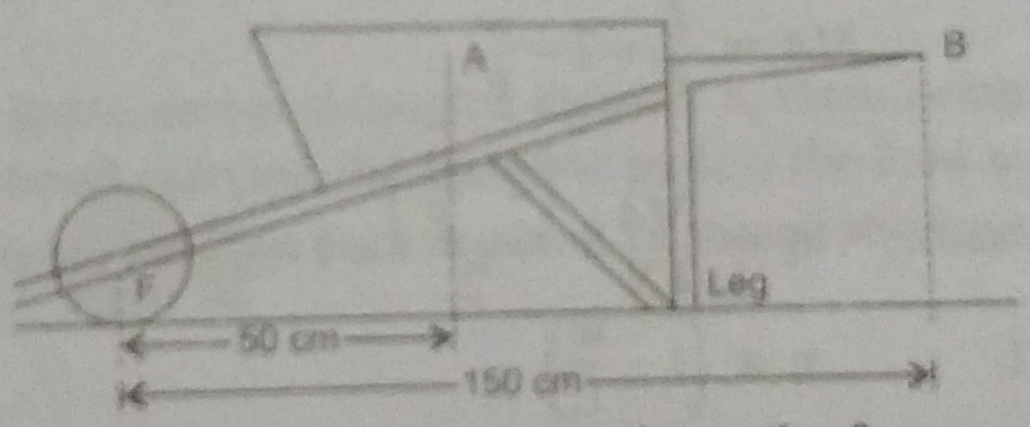
142. Why are the cutting edges of scissors made longer than the cutting edges of metal cutter?

Ans. In scissors, cutting edge (load arm) is generally longer than effort arm because the load (cloth/paper) is of small magnitude than the effort available from hands while in metal cutter load of metal is very large. Thus, to overcome this large resistance, effort arm is made longer so that output can be obtained by applying less effort.

143. Explain why scissors for cutting cloth may have blades much longer than the handles; but shears for cutting metals have short blades and long handles.

Ans. Scissors for cutting cloth and shears for cutting metals both belong to class I levers. For class I levers mechanical advantage (MA = Effort arm/Load arm) may be >, = or <1. For cutting cloth less mechanical advantage is required than for cutting metals. That is why scissors may have blades much longer than the handles. On the other hand shears for cutting metals have short blades and long handles.

144. In the diagram of a stationary wheelbarrow, the centre of gravity is at A. The wheel and the leg are in contact with the ground. The horizontal distance between A and F is 50 cm and that between B and F is 150 cm.



(a) What is the direction of the force acting at A? Name the force.
(b) What is the direction of the minimum force at B to keep the leg off the ground? What is this force called?

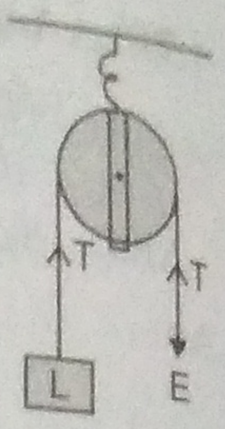
Ans. (a) At point A, the weight of wheelbarrow and sand acts vertically downwards. It is called load.
(b) The direction of the minimum force at B to keep the leg off the ground vertically upwards is called effort and denoted by E.

145. (a) State the class of levers and the relative positions of load (L), effort (E) and fulcrum (F) in each of the following cases:
(i) A bottle opener (ii) Sugar tongs.
(b) Why is less effort needed to lift a load over an inclined plane as compared to lifting the load directly? **[2012]**

Ans. (a) (i) Bottle opener is class II lever in which load is in between fulcrum and effort.
(ii) Sugar tongs is a class III lever in which effort is in between load and fulcrum.
(b) To lift a load over an inclined plane as compared to lifting the load directly, less effort is required because mechanical advantage of inclined plane is greater than one.

146. What is a single fixed pulley? Give its one use.

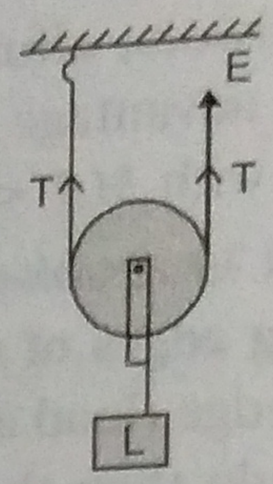
Ans. A single fixed pulley is a metallic/wooden grooved rim of the pulley which can rotate about an axis passing through its fixed centre. An inextensible string of negligible mass passes through the grooved rim of the pulley as shown in the diagram given below.

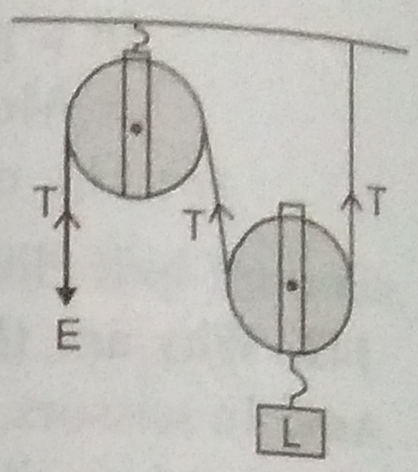


Use: It is used to change the direction of force applied.

147. Draw the diagram of a single movable pulley and obtain its mechanical advantage, velocity ratio and efficiency.

Ans. Since it is inconvenient to apply the effort in an upward direction, a single fixed pulley is used to change the direction of effort.





In equilibrium, $L = T + T = 2T$

$E = T$

$$\text{Mechanical advantage} = \frac{\text{Load } (L)}{\text{Effort } (E)} = \frac{2T}{T} = 2$$

As the effort is pulled down through a distance d_E, the two segments of the thread carrying the movable pulley and the load goes up by $d_E/2$. Hence $d_L = d_E/2$

$$\text{Velocity ratio, } VR = \frac{d_E}{d_L} = \frac{d_E}{d_E/2} = 2$$

$$\text{Efficiency} = \frac{MA}{VR} = \frac{2}{2} = 1 \text{ or } 100\%$$

148. In the above question, if weight of the movable pulley is w, obtain the expression for MA, VR and efficiency.

Ans. If weight of the movable pulley with its frame is w, in equilibrium

$$E = T \qquad L + w = 2T$$

or $$L + w = 2E \quad \Rightarrow \quad L = 2E - w$$

$$MA = \frac{L}{E} = 2 - \frac{w}{E}$$

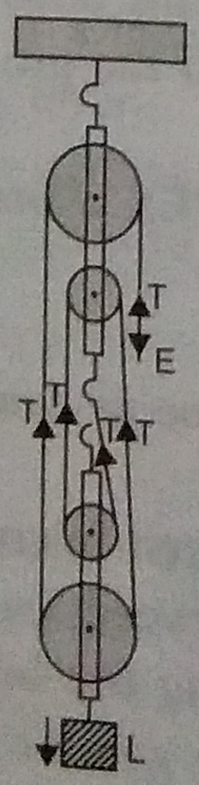
VR will remain the same, $\eta = \dfrac{MA}{VR} = \dfrac{\left(2 - \dfrac{w}{E}\right)}{2} = 1 - \dfrac{w}{2E}$

If $w << 2E$, $2E \simeq L$ $\eta = \left(1 - \dfrac{w}{L}\right)$

149. (*a*) Draw a labelled diagram of a block and tackle system of pulleys with two pulleys in each block. Indicate the directions of the load, effort and tension in the string.

(*b*) Write down the relation between the load and the effort of the pulley system.

Ans. (*a*)



(*b*) Load/Effort = Mechanical advantage

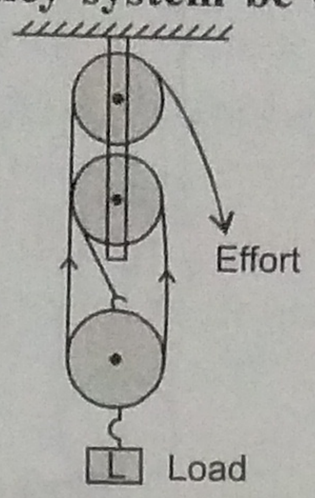
$$MA = \frac{4T}{T} = 4$$

150. A block and tackle pulley system has a velocity ratio 3.

(*a*) Draw a labelled diagram of this system. In your diagram, indicate clearly the points of application and the directions of the load and effort.

(*b*) Why should the lower block of this pulley system be of negligible weight?

Ans. (*a*)



(*b*) If w be the total weight of pulleys in the lower block, in the balanced position

$$\text{Efficiency} = \frac{MA}{VR} = \frac{n - \frac{w}{E}}{n} = 1 - \frac{w}{nE}$$

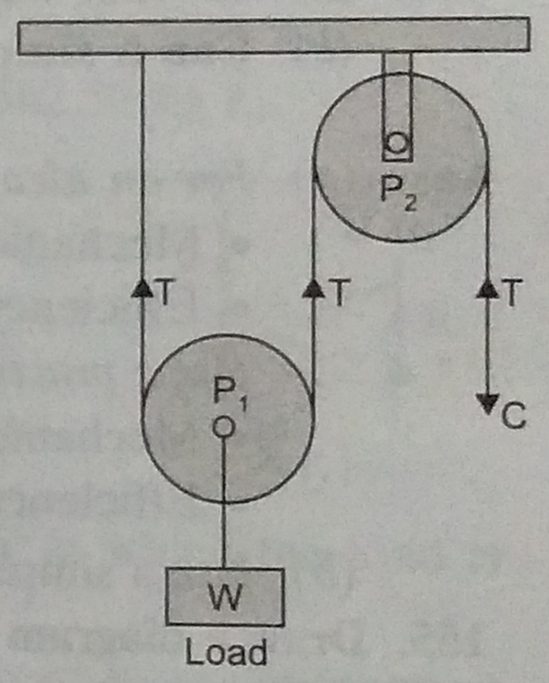
From the expression it is clear that for greater efficiency, $\frac{w}{nE}$ should be negligible. The pulleys in the lower block should be as light as possible.

151. The given figure shows the combination of a movable pulley P_1 with a fixed pulley P_2 used for lifting up a load w.

(*a*) State the function of the fixed pulley P_2.

(*b*) If the free end of the string moves through a distance x, find the distance by which the load w is raised.

(*c*) Calculate the force to be applied at C to just raise the load w = 20 kg f, neglecting the weight of the pulley P_1 and friction.



Ans. (*a*) Fixed pulley P_2 is used to change the direction of effort to a convenient direction.

(*b*) As the free end of the string moves through a distance x, there being two segments of the thread carrying the movable pulley, the load w is raised up by $\frac{x}{2}$ distance ; because each segment of thread shortens by a distance $\frac{x}{2}$.

(*c*) In equilibrium, $L = T + T = 2T$

Force applied at C = Effort $(E) = T$

$$\therefore \quad \frac{L}{E} = \frac{2T}{T} = 2 \Rightarrow \frac{20 \text{ kg f}}{E} = 2 \Rightarrow E = 10 \text{ kg f}$$

152. A type of single pulley is very often used as a machine even though it does not give any gain in mechanical advantage.

(*a*) Name the type of pulley used.

(*b*) For what purpose is such a pulley used? **[2013]**

Ans. (*a*) Single fixed pulley.

(*b*) Single fixed pulley is used to change the direction of effort applied.

153. A block and tackle system of pulleys has a velocity ratio 4.

(*a*) Draw a labelled diagram of the system indicating clearly the points of application and directions of load and effort.

(*b*) What is the value of the mechanical advantage of the given pulley system if it is an ideal pulley system? **[2013]**