

5 MACHINES

I. Tick (✓) the most appropriate answer.

1. In the lever of third order :
 - (a) fulcrum is in the middle of L and E
 - (b) load is in the middle of F and E
 - (c) effort is in the middle of F and L
 - (d) none of these
2. In case of lever of second order :
 - (a) load arm is always longer than effort arm
 - (b) load arm is always smaller than effort arm
 - (c) load arm is always equal to effort arm
 - (d) load arm is sometimes bigger and sometime smaller than effort arm
3. A staircase is an example of :
 - (a) lever
 - (b) wedge
 - (c) inclined plane
 - (d) wheel and axle
4. A nail cutter is an example of :
 - (a) lever of first order
 - (b) lever of second order
 - (c) lever of third order
 - (d) a complicated machine
5. A door knob is an example of :
 - (a) single fixed pulley
 - (b) single movable pulley
 - (c) screw
 - (d) wheel and axle
6. A spade is an example of :
 - (a) lever of first order
 - (b) inclined plane
 - (c) lever of third order
 - (d) wedge
7. The lever in which force applied is always more than the load lifted is :
 - (a) lever of first order
 - (b) lever of third order
 - (c) lever of second order
 - (d) none of these
8. Machines require proper maintenance :
 - (a) for their efficient use
 - (b) for preserving them
 - (c) for making them look good
 - (d) none of these

9. A pulley is a simple machine used to :
 - (a) multiply force
 - (b) apply a force at a convenient point
 - (c) apply a force in a convenient direction
 - (d) none of these
10. A force applied to a machine to do mechanical work is called :
 - (a) effort (b) load (c) efficiency (d) output
11. Wheelbarrow is an example of :
 - (a) lever of the first order (b) lever of the second order
 - (c) lever of the third order (d) inclined plane
12. Scissors are an example of :
 - (a) inclined plane (b) lever of the first order
 - (c) lever of the second order (d) lever of the third order
13. If the effort arm is longer than the load arm :
 - (a) mechanical advantage is less than one
 - (b) mechanical advantage is equal to one
 - (c) mechanical advantage is more than one
 - (d) none of these
14. Which type of lever always reduces the force applied?
 - (a) lever of the first order
 - (b) lever of the second order
 - (c) lever of the third order (d) all of these
15. Machines require proper care and maintenance :
 - (a) to make them look good
 - (b) for preserving them for future
 - (c) for their efficient and longer use
 - (d) none of these
16. The moving parts of the machine should be :
 - (a) painted (b) lubricated (c) covered (d) none of these
17. Efficiency of a machine is :
 - (a) $\text{output} \times \text{input}$ (b) $\text{output}/\text{input}$
 - (c) $\text{input}/\text{output}$ (d) $\text{output} + \text{input}$
18. Levers are of :
 - (a) one kind (b) two kinds (c) three kinds (d) any number

19. For class-I lever :
(a) M.A. = 1 (b) M.A. > 1 (c) M. A. < 1 (d) all of these
20. For class-III lever :
(a) V.R. = 1 (b) V.R. < 1 (c) V.R. > 1 (d) none of these
21. A wire cutter is an example of :
(a) lever of first order (b) lever of second order
(c) lever of third order (d) none of these
22. In case of a movable pulley :
(a) M.A. = 1 (b) M.A. > 2 (c) M.A. < 1 (d) M.A. = 2
23. Mechanical advantage of a machine is
(a) Load $\times$ Effort (b) Load/Effort
(c) Load + Effort (d) Effort/Load
- Ans.** 1. (c) 2. (b) 3. (c) 4. (a) 5. (d) 6. (c) 7. (b) 8. (a) 9. (c)
10. (a) 11. (b) 12. (b) 13. (c) 14. (b) 15. (c) 16. (b) 17. (b)
18. (c) 19. (d) 20. (b) 21. (a) 22. (d) 23. (b).

II. Fill in the blanks.

- Lever is a straight or bent rigid bar capable of turning around a fixed point called _____ .
- When the fulcrum is in the middle of effort and load the lever is said to be of _____ order.
- In case of lever of _____ order, the effort arm is always longer than load arm.
- A door knob is an example of _____ .
- A single fixed pulley can change the _____ of effort.
- A rotating inclined plane is called _____ .
- The _____ parts of a machine should be lubricated.
- The non-movable parts of machine should be _____ to prevent rusting.
- A complex machine consists of several _____ machines working together.
- In the lever of _____ order, the effort arm is always smaller than the load arm.
- A lever consists of a rod free to turn about the _____ .

12. A pulley is a simple machine which helps us in changing the _____ of force.
13. A bottle-opener is an example of the lever of _____ order.
14. A fishing rod is an example of lever of _____ order.
15. _____ is used to lift heavy objects like cars.
16. Thread of a screw is really an _____ wrapped round the screw.
17. In levers of the third order, the mechanical advantage is always _____ than one.
18. The ratio of the load lifted to the effort applied is called _____.
19. A jack is used to _____ force.
20. A nut cracker is a lever of _____ order.
21. In class one lever _____ is in between load and effort.
22. Class two lever acts as a _____ multiplier.
23. A single fixed pulley is used to _____ the direction of applied force.
24. Mechanical advantage of a machine is _____ than 100 per cent.
25. Chisel is an example of _____.
26. A crowbar is a lever of _____ order.
27. Moving parts of a machine is lubricated to _____ friction.

Ans. 1. fulcrum 2. first 3. second 4. wheel and axle 5. direction
6. screw 7. moving 8. painted 9. simple 10. third 11. fulcrum
12. direction 13. second 14. third 15. screw jack 16. inclined plane
17. less 18. Mechanical advantage (M.A.) 19. multiply
20. second 21. fulcrum 22. force 23. change 24. less 25. wedge
26. first 27. reduce.

III. State whether the following statements are true or false (T/F):

1. Fulcrum is in the middle of load and effort in case of lever of first order.
2. Effort is in the middle of fulcrum and load in case of lever of third order.
3. A winding staircase is an example of screw.

4. Dust free air increases the life of a machine.
5. Wheelbarrow is a lever of third order.
6. A door knob is an example of screw.
7. A ramp used for pushing scooter up a slope is an example of inclined plane.
8. An axe is an example of a wedge.
9. A lever of second order is used for breaking nuts.
10. A hill road is an example of a screw.

Ans. 1. T 2. T 3. F 4. T 5. F 6. F 7. T 8. T 9. T 10. F.

IV. Statements given below are incorrect. Write the correct statements.

1. Load arm is the distance between the point where load acts and the point where effort acts.

Ans. Load arm is the distance between the point where load acts and the fulcrum.

2. In case of lever of third order, the effort arm is always longer than load arm.

Ans. In case of lever of third order, the effort arm is always smaller than load arm.

3. In case of lever of second order, the load arm is always longer than effort arm.

Ans. In case of lever of second order, the load arm is always smaller than effort arm.

4. A knife is an example of an inclined plane.

Ans. A knife is an example of wedge.

5. A fishing rod is an example of lever of second order.

Ans. A fishing rod is an example of lever of third order.

6. A single fixed pulley is superior than single movable pulley.

Ans. A single movable pulley is superior than a single fixed pulley.

7. A ramp is an example of screw.

Ans. A ramp is an example of inclined plane.

8. Bicycle is an example of a simple machine.

Ans. Bicycle is an example of a complex machine.

9. A staircase is an example of screw.

Ans. A staircase is an example of inclined plane.

10. Class three levers help us to multiply force.

Ans. Class two levers help us to multiply force.

11. A nail is an example of lever.

Ans. A nail is an example of a wedge.

12. The ratio of load to the effort is called velocity ratio of the machine.

Ans. The ratio of load to the effort is called the mechanical advantage of the machine.

13. Friction increases efficiency of a machine.

Ans. Friction reduces efficiency of a machine.

14. A door knob is an example of a screw.

Ans. A door knob is an example of wheel and axle.

15. An axe is an example of a screw.

Ans. An axe is an example of a wedge.

16. The efficiency of a machine is always greater than 100 per cent.

Ans. The efficiency of a machine is always less than 100 per cent.

17. Single fixed pulley is an example of Class-II lever.

Ans. Single fixed pulley is an example of class-I lever.

18. Input energy is the useful work done by a machine.

Ans. Output energy is the useful work done by a machine.

19. A nut-cracker is an example of a lever of the third order.

Ans. A nut-cracker is an example of a lever of second order.

20. A pulley enables us to apply a force in the upward direction.

Ans. A pulley enables us to apply a force in the convenient direction.

21. All machines do not require proper care.

Ans. All machines require proper care.

22. Load is the force applied by the machine on the body on which the work is done by it.

Ans. Effort is the force applied by the machine on the body on which the work is done by it.

23. The ratio of the load arm and the effort arm is the mechanical advantage of a simple machine.

Ans. The ratio of the effort arm and the load arm is the mechanical advantage of a lever.

24. Sewing machine is an example of a simple machine.

Ans. Sewing machine is an example of a complex machine.

25. Crowbar helps us to obtain gain in speed.

Ans. Crowbar helps us to multiply force.

VI. Find the odd one out. Give a reason for your choice.

1. Wheelbarrow, bicycle, beam balance, knife.

Ans. Bicycle: Bicycle is a complex machine but other are simple machines.

2. Sugar tongs, wheelbarrow, screw jack, fishing rod.

Ans. Screw Jack: Only screw jack is an example of screw other are examples of lever.

3. Cart wheel, ramp, gang plank, staircase.

Ans. Cart wheel: Cart wheel is an example of wheel and axle but other are examples of inclined plane.

4. Scissors, lock and key, nut cracker, oars of a boat.

Ans. Lock and key: Lock and key is not an example of lever but other are examples of a lever.

5. Ice tongs, claw hammer, crowbar, see-saw.

Ans. Ice tongs: Only ice tong is an example of lever of third order. But other are examples of lever of first order.

6. Pulley, inclined plane, watch, screw jack.

Ans. Watch: Watch is a complex machine but other are examples of simple machine.

7. Mango-cutter, nut-cracker, bottle-opener, spade.

Ans. Spade: Only spade is an example of lever of third order but other are examples of lever of second order.

8. Pair of scissors, bread knife, water pump, see-saw.

Ans. Bread knife: Only bread knife is an example of lever of third order but other are examples of lever of first order.

9. Ramp, revolving staircase, wheel, wooden plank.

Ans. Wheel: Only wheel is not an example of inclined plane.

10. Bottle-opener, screw jack, lemon squeezer, a pair of tongs.

Ans. Screw Jack: Screw jack is an example of screw but other are examples of lever.

11. Fire tong, bottle opener, seesaw, bolt.

Ans. Bolt: Bolt is an example of screw but other are examples of lever.

12. Inclined plane, screw, wedge, watch.

Ans. Watch: Watch is a complex machine but other are simple machines.

13. Bottle opener, wheelbarrow, nutcracker, human forearm.

Ans. Human forearm: Human forearm is an example of lever of third order but other are examples of lever of second order.

VII. Match the following:

<i>Column A</i>	<i>Column B</i>
1. $\frac{\text{Load}}{\text{Effort}}$	(a) A pair of fire tong
2.	(b) Bottle opener
3. Class one lever	(c) Crowbar
4. Class two lever	(d) Mechanical advantage
5. Class three lever	(e) Efficiency
6. Inclined plane	(f) Velocity ratio
7. Screw	(g) Knife
8. Wedge	(h) Screwdriver
9. Wheel and axle	(i) Ramp
10.	(j) Bolt

Ans. 1. (d) 2. (e) 3. (c) 4. (b) 5. (a) 6. (i) 7. (j) 8. (g) 9. (h)
10. (f)

VIII. Give reasons for the following.

1. A machine cannot be 100 per cent efficient.

Ans. A machine cannot be 100 per cent efficient because output of a machine is always less than input. A certain amount of work-done on the machine is lost to overcome friction and to lift some moving parts of the machine.

2. The mechanical advantage of a lever of the third order is always less than one.

Ans. The mechanical advantage of a lever of the third order is always less than one because the effort arm is always less than the load

arm. And mechanical advantage = $\frac{\text{load}}{\text{effort}} = \frac{\text{effort arm}}{\text{load arm}}$

3. Hill roads are built to have gradual slopes.

Ans. Hill roads are built to have gradual slopes so that a vehicle can climb up easily.

4. A lever of the second order always increases force.

Ans. A lever of the second order always increases force as the effort arm is always greater than load arm. And according to the principle of lever, load × load arm = effort × effort arm.

5. A pulley has a groove cut along its rim.

Ans. Because, the groove prevents the rope from slipping of the disc.

6. Mechanical advantage of second class lever is always greater than one.

Ans. Because the effort arm of second order lever is longer than its

load arm. And mechanical advantage = $\frac{\text{effort arm}}{\text{load arm}}$. The

mechanical advantage of Second class lever is always greater than one.

7. In a lever of third order, there is always a gain in speed.

Ans. In a lever of third order, there is always a gain in speed.

Because the mechanical advantages of the lever of third order is always less than one as effort arm is shorter than load arm.

8. Inclined plane makes our task easier.

Ans. Because inclined plane helps us to multiply force and helps us to lift heavy loads with relatively little effort.

IX. Classify the following:

- | | | |
|----------------|------------------|------------------------|
| 1. Wheelbarrow | 2. Bicycle pedal | 3. Car jack |
| 4. Door knob | 5. Ladder | 6. Jar lid |
| 7. Nails | 8. Nut cracker | 9. Airplane propellers |
| | | 10. Screw driver |

Ans. 1. **Wheel barrow** — Lever of second order

2. **Bicycle pedal** — Wheel and axle

3. **Car jack** — Screw.

4. **Door knob** — Wheel and axle.

5. **Ladder** — Inclined Plane.

6. **Jar lid** — Screw.

7. **Nails** — Wedge.

8. **Nut cracker** — Lever of second order.

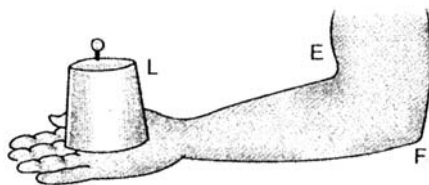
9. **Aeroplane propellers** — Wheel and axle.

10. **Screw driver** — Wheel and axle.

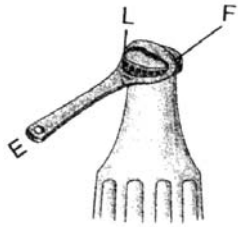
X. Classify the following levers. Draw diagrams showing fulcrum, points of application of the load and effort.

1. Human arm holding a load, 2. Bottle-opener, 3. Pincers
4. Nut-cracker, 5. A bread knife, 6. See-saw, 7. Spade
8. Wheelbarrow.

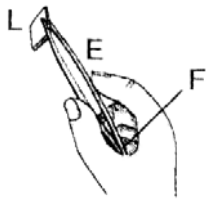
Ans. 1. Lever of third order.



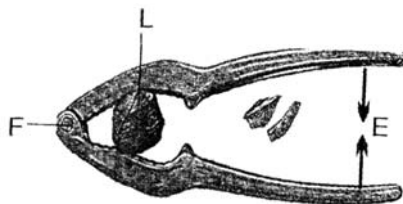
2. Lever of second order.



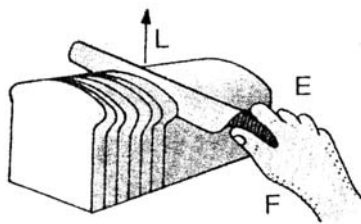
3. Lever of third order



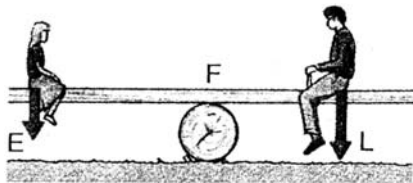
4. Lever of second order.



5. Lever of third order



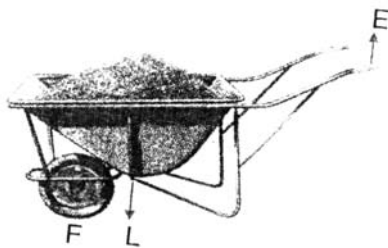
6. Lever of first order.



7. Lever of third order.



8. Lever of second order.



XI. Answer these questions.

1. (a) What do you understand by the term machine?
(b) Name six simple machines.

Ans. (a) A machine is a device which helps us to lift heavy loads, or speed up the motion or change the direction of force in a desired direction.

(b) Six simple machines are see-saw, claw hammer, scissors, bread knife, nut-cracker and wheelbarrow.

2. State three objectives which can be achieved by a machine.

Ans. Three objectives which can be achieved by a machine are

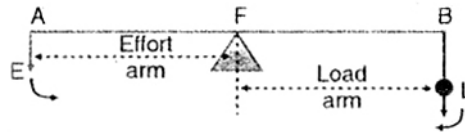
- (i) to lift a heavy load by applying a small effort i.e. to multiply effort.
- (ii) to speed up the motion of a body.
- (iii) to change the effort in the desired direction.

3. (a) Define lever.
(b) By showing clearly the position of effort, load and fulcrum, draw simplified diagrams for (i) lever of first order (ii) lever of second order (iii) lever of third order.

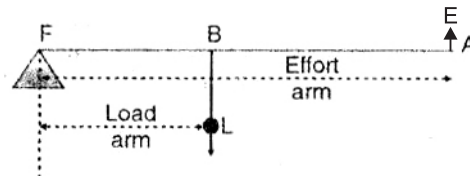
Ans. (a) A lever is a rigid bar which can rotate about a fixed point or a fixed line, called the axis of rotation.

(b)

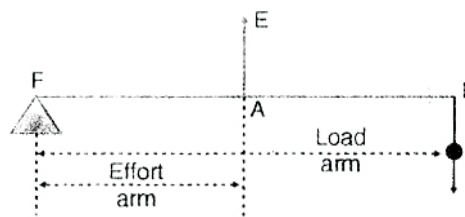
- (i) Lever of 1st order (fulcrum in-between the effort and load).



- (ii) Lever of 2nd order (load in-between the fulcrum and effort).



- (iii) Lever of 3rd order (effort in-between the fulcrum and load).



4. Give two examples each for the levers of first, second and third order.

Ans. Lever of first order: see-saw, crowbar.

Lever of second order: bottle opener, nut-cracker.

Lever of third order: sugar tongs, bread knife.

5. Classify the following as levers of first, second and third order:
(i) Forceps (ii) wheelbarrow (iii) Pliers (iv) fishing rod
(v) nut-cracker (vi) see-saw.

Ans. (i) Forceps — Lever of first order.
(ii) Wheelbarrow — Lever of second order.
(iii) Pliers — Lever of first order.
(iv) Fishing rod — Lever of third order.
(v) Nut-cracker — Lever of second order.
(vi) See-saw — Lever of first order.

6. (a) What for single pulley is commonly used?
(b) Draw a neat diagram of a single movable pulley and state its one use.

Ans. (a) Single pulley is commonly used in drawing water from village wells.
(b)

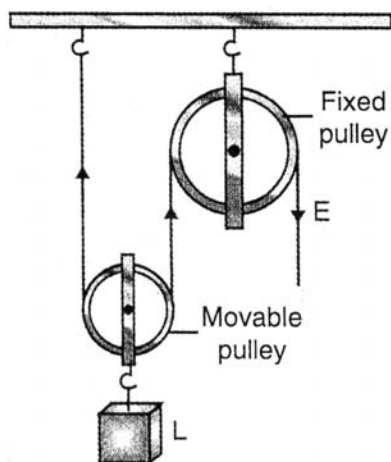


Fig. Single movable pulley system.

It is used in the crane for lifting heavy load with a small force.

7. (a) What is an inclined plane?
(b) Give four examples of inclined plane, commonly used in daily life.

Ans. (a) An inclined plane is any sloping flat surface along which a load can be easily pushed or pulled.
(b) Four examples of inclined plane are ramp, a gang plank, winding staircase and hill road.

8. (a) What is a wedge? Give three examples of wedge.
(b) What for a wedge is employed commonly?

Ans. (a) A wedge is a double inclined plane.
Three examples of wedge are knife, axe, chisel.
(b) A wedge is commonly employed to tear apart solid objects like wood.

9. What is wheel and axle? Give two examples of wheel and axle.

Ans. Wheel and axle essentially consist of two cylinders of different diameters joined together, such that if one is made to rotate the other also rotates.

Two examples of wheel and axle are steering wheel of a car, a screwdriver.

10. (a) What is a screw?
(b) Give three uses of screw.

Ans. (a) A screw is a rotating (winding) inclined plane.
(b) Three uses of screw are
(i) they are used to fasten two pieces of wood or metal.
(ii) screw jack is used for lifting one side of a car or a truck, in order to change the punctured wheel.
(iii) a cork screw is used for pulling out cork from the bottles of wine or ketchup.

11. Define mechanical advantage.

Ans. Mechanical advantage is the ratio between useful load moved to the effort applied. It is measured as

$$\text{M.A.} = \frac{\text{Load}}{\text{Effort}} = \frac{\text{Effort arm}}{\text{Load arm}}$$

12. Define velocity ratio and efficiency.

Ans. Velocity ratio is the ratio of the velocity of effort to the velocity of load.

Velocity ratio =

Efficiency of a machine is the ratio of the work output to the work input.

16. How do you distinguish between a lever of first order and second order?

Ans. Lever of first order	Lever of second order
(i) Fulcrum is between load and effort	(i) Load is between fulcrum and effort
(ii) The effort and load move in opposite direction.	(ii) The effort and load move in the same direction.
(iii) M.A. can be equal to 1 or less than 1 or greater than 1.	(iii) M.A. is always greater than 1.

14. What is the mechanical advantage of an inclined plane?

Ans. The mechanical advantage of the inclined plane is the ratio of the slope of the inclined plane to the vertical rise.

15. Give one advantage of using a pulley.

Ans. One advantage of using a pulley is that it allows us to apply the force in a convenient direction.

16. Name two ways for the maintenance of the machine.

Ans. The two ways for the maintenance of the machine are
 (i) The non-movable parts of the machine should be painted, and
 (ii) The machines should be protected from dust which increases the wear and tear of the machines.

17. What are the three ways by which a simple machine makes our work easier, faster and more convenient?

Ans. The three ways by which a simple machine makes our work easier, faster and more convenient are :

- (i) Applying a force in a convenient direction,
- (ii) Multiplying the force, and

(iii) Applying a force at a convenient point.

18. Name two simple machines in each case in which we

(a) apply force in a convenient direction.

(b) multiply force.

(c) apply force at a convenient point.

Ans. (a) Apply force in a convenient direction: Simple pulley, incline plane (ramp)

(b) Multiply force: Lemon squeezer, bottle opener.

(c) Apply force at a convenient point: Screwdriver, handle of the scissors.

19. Suggest a way by which a single person can easily load a heavy drum onto a truck.

Ans. By using inclined plane.

20. Give two examples where the inclined plane idea has been used to multiply force.

Ans. (i) The inclined planes called ramps are provided in hospitals for carrying patients.

(ii) Hill roads have gradual slope so that a bus can climb up easily.

21. Name the two factors by which a machine's ability to do work is measured.

Ans. Two factors by which a machine's ability to do work is measured are its efficiency and mechanical advantage.

22. Why do all machines require proper care and maintenance?

Ans. All machines require proper care and maintenance for their efficient and longer use.

23. List three ways by which the maintenance of machines can be done.

Ans. Three ways by which the maintenance of machines can be done are

(i) all machines should be placed in a clean place to keep away dust and moisture.

- (ii) the moving parts of a machine should be lubricated with a good quality machine oil to reduce friction.
- (iii) machines made of iron should be painted to avoid rusting.

XIII. Numerical Problems:

1. A load of 200 N can be lifted by a force of 50 N with the help of a lever. Find the mechanical advantage.

Ans. Load = 200 N
Effort = 50 N
Mechanical advantage = ?

$$\text{M.A. of the lever} = \frac{\text{Load}}{\text{Effort}} = \frac{200\text{N}}{50\text{N}} = 4$$

2. Calculate the force required to lift a load of 100 N with the help of a lever whose mechanical advantage is 2.

Ans. Load = 100 N
Mechanical advantage (M.A.) = 2
Effort = ?

$$\text{M.A. of a lever} = \frac{\text{Load}}{\text{Effort}}$$

$$\Rightarrow 2 = \frac{100\text{N}}{\text{Effort}}$$

$$\therefore \text{Effort (Force)} = \frac{100\text{N}}{2} = 50\text{N}.$$

3. A boy of mass 20 kg sits at a distance of 80 cm from the fulcrum of a see-saw. Calculate the mass of another boy who sits at a distance of 16 cm from the fulcrum such that the see-saw is balanced.

Ans. We know that,
Load $\times$ Load Arm = Effort $\times$ Effort Arm
 $\Rightarrow 20\text{ kg} \times 80\text{ cm} = \text{Effort} \times 16\text{ cm}.$

$$\therefore \text{Effort} = \frac{20 \text{ kg} \times 80 \text{ cm}}{16 \text{ cm}} = 100 \text{ kg.}$$

4. From the data given to you find the unknown quantity.
- (a) Load = 100 N, effort = 20 N, mechanical advantage = ?
 - (b) Load = 200 N, effort = ?, mechanical advantage = 4.
 - (c) Load = ?, effort = 10 N, mechanical advantage = 2.
 - (d) Load arm = 2 m, load = 40 N, effort arm = 5 m, effort = ?
 - (e) Load arm = 4 m, load = 20 N, effort arm = ?, effort = 8 N
 - (f) Load arm = 5m, load = ?, effort arm = 10 m, effort = 10 N.
 - (g) Load arm = ?, load = 20 N, effort arm = 5 m, effort = 4 N.

Ans. (a) Mechanical advantage = $\frac{\text{Load}}{\text{Effort}} = \frac{100 \text{ N}}{20 \text{ N}} = 5$

(b) Mechanical advantage = $\frac{\text{Load}}{\text{Effort}}$

$$\Rightarrow 4 = \frac{200 \text{ N}}{\text{Effort}}$$

$$\therefore \text{Effort} = \frac{200}{4} = 50 \text{ N.}$$

(c) Mechanical advantage = $\frac{\text{Load}}{\text{Effort}}$

$$\Rightarrow 2 = \frac{\text{Load}}{10 \text{ N}}$$

$$\therefore \text{Load} = 20 \text{ N.}$$

(d) Load $\times$ Load arm = Effort $\times$ Effort arm

$$\Rightarrow 40 \times 2 = \text{Effort} \times 5 \text{ m}$$

$$\therefore \text{Effort} = \frac{80 \text{ N}}{5} = 16 \text{ N}$$

$$\begin{aligned} \text{(e) Load} \times \text{Load arm} &= \text{Effort} \times \text{Effort arm} \\ \Rightarrow 20 \text{ N} \times 4 \text{ m} &= 8 \text{ N} \times \text{Effort arm} \end{aligned}$$

$$\therefore \text{Effort arm} = 10 \text{ m}$$

$$\begin{aligned} \text{(f) Load} \times \text{Load arm} &= \text{Effort} \times \text{Effort arm} \\ \Rightarrow \text{Load} \times 5 \text{ m} &= 10 \text{ N} \times 10 \text{ m} \end{aligned}$$

$$\therefore \text{Load} = 20 \text{ N}$$

$$\begin{aligned} \text{(g) Load arm} \times \text{Load} &= \text{Effort arm} \times \text{Effort} \\ \Rightarrow \text{Load arm} \times 20 \text{ N} &= 5 \text{ m} \times 4 \text{ N} \end{aligned}$$

$$\therefore \text{Load arm} = \frac{5 \text{ m} \times 4 \text{ N}}{20 \text{ N}} = 1 \text{ m.}$$

5. The mechanical advantage of a machine is 4. Calculate the force required to lift a load of 100 N.

Ans. Mechanical advantage = 4

$$\text{Load} = 100 \text{ N}$$

$$\text{Effort} = ?$$

$$\text{Mechanical advantage} = \frac{\text{Load}}{\text{Effort}}$$

$$\Rightarrow 4 = \frac{100 \text{ N}}{\text{Effort}}$$

$$\therefore \text{Effort} = \frac{100 \text{ N}}{4} = 25 \text{ N}$$

6. 20 N effort is required to lift a stone of weight 120 N. Find the mechanical advantage.

Ans. Load = 120 N

$$\text{Effort} = 20 \text{ N}$$

Mechanical advantage = ?

$$\text{Mechanical advantage} = \frac{\text{Load}}{\text{Effort}} = \frac{120 \text{ N}}{20 \text{ N}} = 6$$

7. Find the mechanical advantage of a lever in which load arm is 2 m and the effort arm is 6 m.

Ans. Load arm = 2 m

Effort arm = 6 m

Mechanical advantage = ?

$$\text{Mechanical advantage} = \frac{\text{Effort arm}}{\text{Load arm}} = \frac{6 \text{ m}}{2 \text{ m}} = 3.$$

8. A lever of class-1 has a total length of 3 m and is able to lift a load of 60 N with a force of 30 N. Find the position of the fulcrum.

Ans. Load = 60 N

Effort = 30 N

Let, x be the distance of fulcrum from the load.

$$\therefore \text{Effort arm} = (3 - x)$$

We know that

$$\text{Load} \times \text{Load arm} = \text{Effort} \times \text{Effort arm}$$

$$\Rightarrow 60 \text{ N} \times x = 30 \times (3 - x)$$

$$\Rightarrow 60x = 90 - 30x$$

$$\Rightarrow 90x = 90$$

$$\therefore x = 1 \text{ m.}$$

Therefore position of the fulcrum is 1 m from the load.

9. A single movable pulley is to be used to lift a load of 800 N. What effort is required?

Ans. Load = 800 N

Mechanical advantage of single movable pulley = 2

$$\text{Mechanical advantage} = \frac{\text{Load}}{\text{Effort}}$$

$$\therefore 2 = \frac{\text{Load}}{\text{Effort}}$$

$$\therefore \text{Effort} = \frac{\text{Load}}{\text{Effort}} = 400 \text{ N}$$

10. An effort of 200 N is applied to an ideal single fixed pulley. Calculate

(a) load moved (b) mechanical advantage (c) velocity ratio

Ans. For an ideal single fixed pulley. Effort = Load

(a) Load moved by an effort of 200 N is 200 N

$$(b) \text{ Mechanical advantage} = \frac{\text{Load}}{\text{Effort}} = \frac{200 \text{ N}}{200 \text{ N}} = 1$$

(c) Velocity ratio

$$= \frac{\text{Distance through which the effort moves}}{\text{Distance through which the load moves}} = 1.$$
