PHYSICS

BOOKS - SELINA PHYSICS (ENGLISH)

MACHINES

Examples

1. A machine is driven by a 100 kg mass that falls $8m$ in $4 \cdot 0$s. it lifts a load of mass 500 kg vertically upwards. Taking $g = 10ms^{-2}$.

Calculate:

(a) the force exerted by the falling mass.

(b) the work done by the falling mass in its displacement by $8 \cdot 0$m.

(c) the power input to the machine.

(d) the power output of the machine if its efficiency is 60%, and

(e) the work done by the machine is $4 \cdot 0$s.

Watch Video Solution

2. Calculate the ideal mechanical advantage of a lever in which the effort arm is 60 cm and the load arm is 4 cm.

Watch Video Solution

3. Draw a simple diagram ofa fire tongs and mark on it the fulcrum F and the points of application of load L and effort E. (a) Name the class of lever. (b) if load arm is 15 cm and effort

arm is 5 cm. what is its mechanical adavantage?

Watch Video Solution

4. A crowbar 2 m long is pivoted about a point 10 cm from its tip.

(i) Calculate the mechanical advantage of the crowbar.

(ii) What is the least force which must be applied at the other end to displace a load of 100 kgf?

Watch Video Solution

5. A uniform seesaw, 5m long, is supported at its centre. A boy weighing 40 kgf sits at a distance of 1 m from the centre of the seesaw.

(i) To which class of lever does it belong ?

(ii) Find where a girl of weight 20 kgf must sit on the seesaw so as the balance the weight of the boy.

Watch Video Solution

6. A cook uses a fire tongs of length 28 cm to lift a piece of burning coal of mass 250 g. if he applies effort at a distance of 7 cm from the fulcrum, find the effort. Take g=$10ms^{-2}$.

Watch Video Solution

7. The diagram below shows a lever in use.

(a) To which class of lever does it belong ? Give

one example of this class.

(b) How will the mechanical advantage of lever change if load is shifted towards the fulcrum without changing it's dimensions.

Watch Video Solution

8. (a) (i) State the principle of moments as applied to the lever shown in Figure. And

(ii) calculate its mechanical advantage if

$AB = 2 \cdot 0m$ and $FA = 20cm.$

(b) Calculate the effort needed to lift and load.

Watch Video Solution

9. A nut which can be broken by applying a force of 40 kgf, is broken by using a nut cracker having its handle 20 cm long, by placing it at a distance 2 cm from the hinge. Calculate the minimum force needed to break the nut.

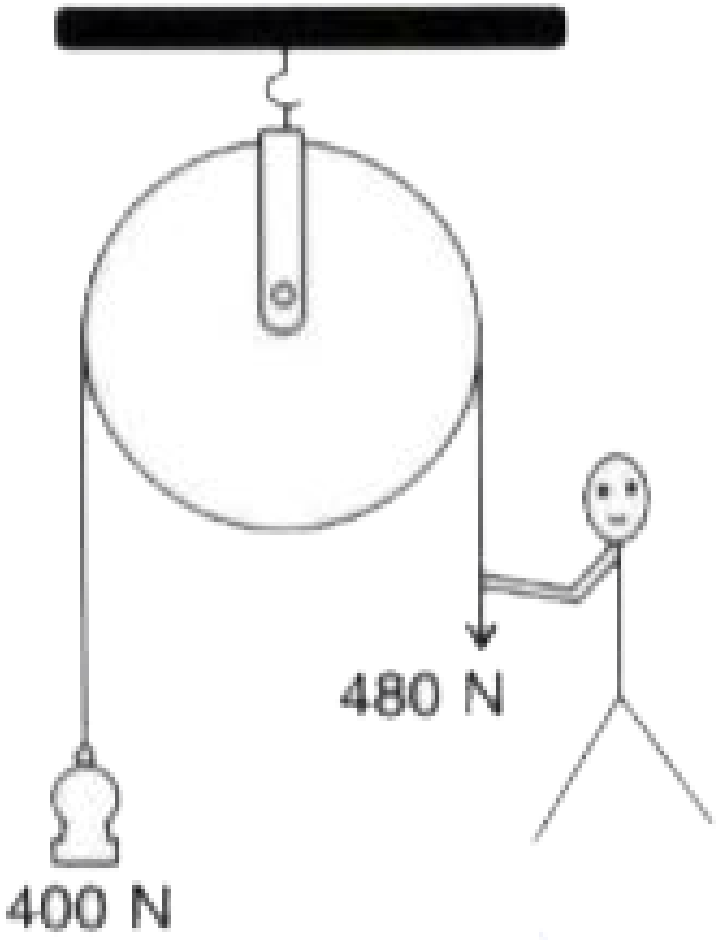
Watch Video Solution

10. A man opens a nut by applying a force of 150 N by using a lever handle of length $0 \cdot 4m$. What should be the length of the handle if he wants to open it by applying a force of 60 N?

Watch Video Solution

11. The adjacent Figure shows a fixed pulley used by a boy to lift a load of 400 N through a vertical height of 5 m in 10 s. the effort applied by the boy on the other end of the rope is 480

N.



(a) What is the velocity ratio of the pulley ?

(b) What is the mechanical advantage ?

(c) Calculate the efficiency of the pully.

(d) Why is the efficiency of the pulley not 100% ?

(e) What is the energy gained by the load in 10 s?

(f) How much power was developed by the boy in raising the load ?

(g) The boy has to apply an effort which is greater than the load he is lifting. what is the justification for using the pulley ?

Watch Video Solution

12. The diagram in Figure shows the combination of two pulleys P_1 and P_2 used to lift up a load W.

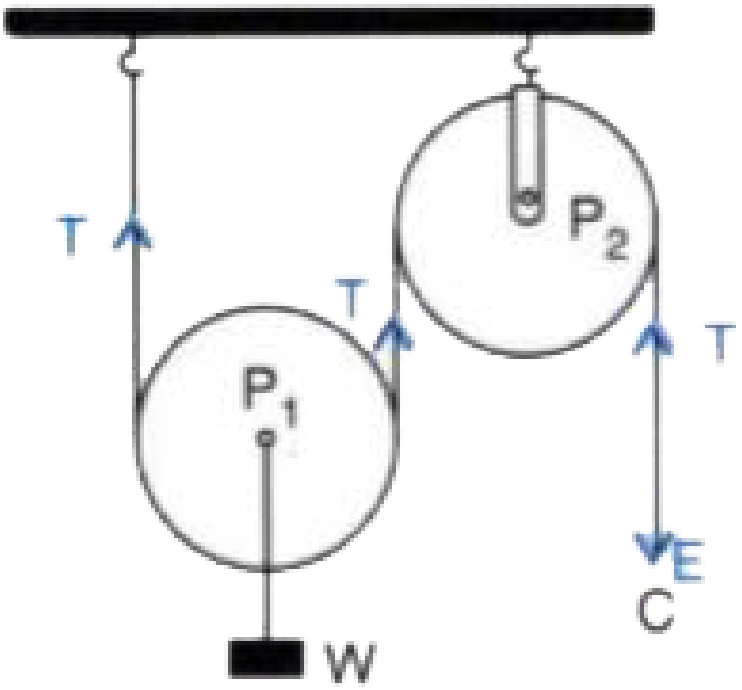
(a) State the kind of pulleys P_1 and P_2.

(b) State the function of the pulley P_2.

(c) If the free end C of the string moves througha distance x, by what distance is the load W raised ?

(d) What effort E has to be applied at C to just raise the load W=20 kgf ? Neglect both the

weight of the pulley P_1 and friction.



Watch Video Solution

13. A pulley system with a velocity ratio of 4 is used to lift a load of 150 kgf through a vertical

height of 20 m. the effort required is 50 kgf in downward direction. Calculate:

(a) the distance moved by the effort.

(b) the work done by the effort.

(c) the mechanical advantage.

(d) the efficiency of the pulley system, and

(e) the total number of pulleys and the number of pulleys in each block.

$\left(g = 10N \quad kg^{-1}\right).$

Watch Video Solution

14. A block and tackle has two pulleys in each block, with the tackle tied to the hook of the lower block and the effort being applied upwards.

(a) draw a neat diagram to show this arrangement and calculate its mechanical advantage.

(b) If the load moves up a distance x, by what distance will the fre end of the string move up ?

Watch Video Solution

Exercise 3 A

1. (a) What do you understand by a simple machine?

(b) State the principle of an ideal machine.

Watch Video Solution

2. State four ways in which machines are useful to us.

Watch Video Solution

3. Name a machine for each of the following use :

(a) to multiple the force,

(b) to change the point of application of force,

(c) to change the direction of force,

(d) to obtain the gain in speed.

Watch Video Solution

4. What is the purpose of a jack in lifting a cary by it?

Watch Video Solution

5. What do you understand by an ideal machine ? How does it differ from a practical machine ?

Watch Video Solution

6. Explain the term mechanical advantage. State its unit.

Watch Video Solution

7. Define the term velocity ratio. State its unit.

Watch Video Solution

8. How is mechanical advantage related to velocity ratio for (i) an ideal machine, (ii) a practical machine ?

Watch Video Solution

9. Define the term efficiency of a machine. Give two reasons for a machine not be 100% efficient?

Watch Video Solution

10. When does a machine act as (a) a force multiplier, (b) a speed multiplier. Can a machine act as a force multiplier and a speed multiplier simultaneously ?

Watch Video Solution

11. A machine works as a (i) force multiplier, (ii) speed multiplier. In each case state whether the velocity ratio is more than or less than 1.

Watch Video Solution

12. (a) State the relationship between mechanical advantage, velocity ratio and efficiency.

(b) Name the term that will not change for a machine of a given design.

Watch Video Solution

13. Derive a relationship between mechanical advantage, velocity ratio and efficiency of a machine.

Watch Video Solution

14. How is mechanical advantage related with velocity ratio for an actual machine ? State

whether the efficiency of such a machine is equal to 1, les sthan 1 or more than 1.

Watch Video Solution

15. State one reason why mechanical advantage is less than the velocity ratio for an actual machine.

Watch Video Solution

16. What is a lever ? State its principle.

Watch Video Solution

17. Write down a relation expressing the mechanical advantage of a lever.

Watch Video Solution

18. Name the three classes of levers and state how are they distinguished. Give two examples of each class.

Watch Video Solution

19. Give one example each of a class I lever where mechanical advantage is (a) more than 1, and (b) less than 1.

Watch Video Solution

20. What is the use of a lever if its mechanical advantage is (a) more than 1, (b) equal to 1, and (c) less than 1.

Watch Video Solution

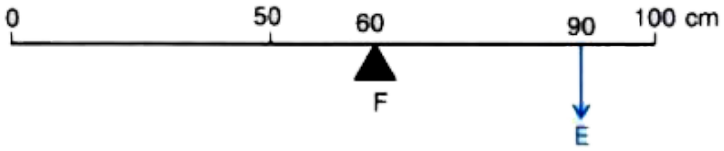
21. Both a pair of scissors and a pair of pliers belong to the same class of levers. Name the class of lever. Which one has mechanical advantage less than 1?

Watch Video Solution

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

Watch Video Solution

23. Figure, shows a uniform metre rule of weight W supported on a fulcrum at the 60 cm mark by applying the effort E at the 90 cm mark.



(a) State with reason whether the weight W of the rule is greater than, less than or equal to the effort E.

(b) Find the mechanical advantage in a ideal case.

Watch Video Solution

24. Which typ eof lever has mechanical advantage always more than 1 ? Give reason with one example. What change can be made in this lever to increase its mechanical advantage ?

Watch Video Solution

25. Draw a diagram of a lever which is always used as a force multiplier. How is the effort arm related to the load arm in such a lever ?

Watch Video Solution

26. Explain why mechanical advantage of a class II lever is always more than 1.

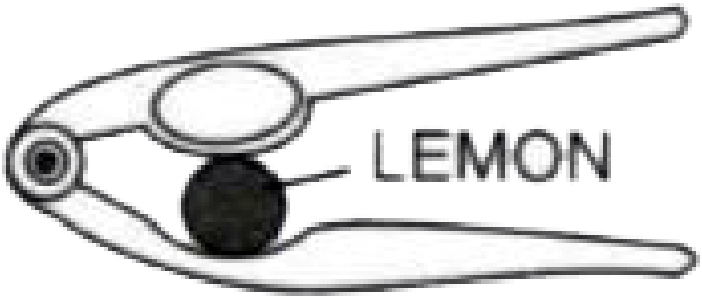
Watch Video Solution

27. Draw a labelled diagram of a class II lever. Give one example of such a lever.

Watch Video Solution

28. Figure, shows a lemon crushes,

(a) In the diagram, mark the position of the fulcrum F and the line of action of load L and effort E.



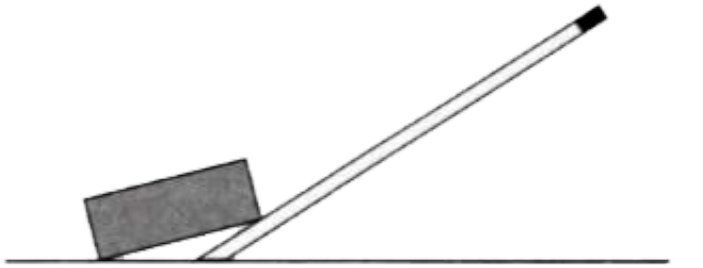
(b) Name the class of lever.

Watch Video Solution

29. The diagram below shows a rod lifting a stone.

(a) Mark position of fulcrum F and draw arrows to show the directions of load L and effort E. (b) What class of lever is the rod ? (c)

Give one more example of the same class of lever stated in part (b).



Watch Video Solution

30. State the kind of lever which always has mechanical advantage less than 1. Draw a labelled diagram of such a lever.

Watch Video Solution

31. Explain why mechanical advantage of class III lever is always less than I.

Watch Video Solution

32. Class III levers have mechanical advantage less than 1. why are they then used ?

Watch Video Solution

33. Draw a labelled sketch of a class III lever. Give one example of this kind of lever.

Watch Video Solution

34. State the class of levers and the relative positions of load (L), effort (E) and fulcrum (F) in (a) a bottle opener, and (b0 sugar tongs.

Watch Video Solution

35. Draw diagrams to illustrate the positions of fulcrum, load and effort, in each of the following :

(a) A seesaw

(b) A common balance

(c) A nut cracker

(d) Forceps.

Watch Video Solution

36. Classify the following into levers as class I, class II or class III:

(a) a door

(b) a catapult

(c) claw hammer

(d) a wheel barrow

(e) a fishing rod.

(f) sugar tongs.

Watch Video Solution

37. What type of lever is formed by a human body while (a) raising a load on the palm, and (b) raising the weight of body on toes ?

Watch Video Solution

38. Indicate the positions of load L, effort E and fulcrum F in the forearm shown alongsind in figure. Name the class of leverl.

Watch Video Solution

39. Give an example of each class of lever in a human body.

Watch Video Solution

40. Complete the following sentence:

(a) Mechanical advantage=____ $\times$ velocity ratio

(b) In class II lever, effort arm is ___than the

load arm.

(c) A pair of scissors is a ____multiplier.

Watch Video Solution

Exercise 3 A Multiple Choice Type

1. Mechanical advantage (M.A.), load (L) and effort (E) are related as :

A. $M.A. = L \times E$

B. $M.A. \times E = L$

C. $E = M.A. \times L$

D. none of these

Answer: B

Watch Video Solution

2. The correct relationship between mechanical advantage (M.A.) velocity ratio (V.R.) and efficiency (η) is:

A. $M.A. = \eta \times V.R.$

B. $V.R. = \eta \times M.A.$

C. $\eta = M.A. \times V.R.$

D. none of these

Answer: A

Watch Video Solution

3. Select the incorrect statement:

A. A machine always has efficiency less than

100%

B. The mechanical advantage of a machine can be less than 1.

C. A machine can be used as a speed multiplier.

D. A machine can have mechanical advantage greater than its velocity ratio.

Answer: D

Watch Video Solution

4. The lever for which mechanical advantage is less than 1 has:

A. fulcrum at the mid point between load and effort.

B. load between effort and fulcrum.

C. effort between fulcrum and load

D. load and effort acting at the same point.

Answer: C

Watch Video Solution

5. Class II levers are designed to have :

A. $M.A. = V.R.$

B. $M.A. > V.R.$

C. $M.A. > 1$

D. $M.A. < 1$

Answer: C

Watch Video Solution

Exercise 3 A Numericals

1. A crowbar of length 120 cm has its fulcrum situated at a distance of 20 cm from the load. Calculate the mechanical advantage of the crowbar.

Watch Video Solution

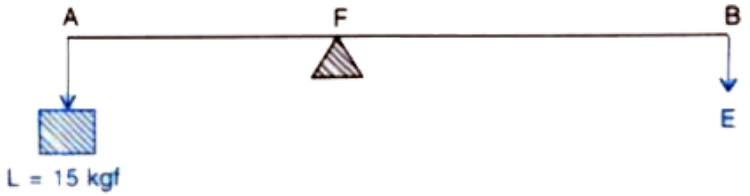
2. A pair of scissors has its blades 15 cm long, while its handles are $7 \cdot 5cm$ long. What is its mechanical advantage ?

Watch Video Solution

3. A force of 5 kgf is required to cut a metal sheet. A pair of shears used for cutting the metal sheet has its blades 5 cm long, while its handles are 10 cm long. What effort is needed to cut the sheet ?

Watch Video Solution

4. Figure below shows a lever in use.



(a) To which class of lever does it belong ?

(b) If AB=1m, AF=0.4m, find its mechanical advantage.

(c) Calculate the value of E.

Watch Video Solution

5. A man uses a crowbar of length 1.5m to raise a load of 75 kgf by putting a sharp edge below the bar at a distance of 1 m from his hand. (a) draw a diagram of the arrangement showing the fulcrum (F), load (L) and effort (E) with their direction. (b) state the kind of lever. (c) Calculate : (i) load arm, (ii) effort arm, (iii) mechanical advantage, and (iv) the effort needed.

Watch Video Solution

6. A pair of scissors is used to cut a piece of cloth by keeping it at a distance of 8.0 cm from its rivet and applying an effort of 10 kgf by fingers at a distance of 2.0 cm from the rivet.

(a) Find : (i) the mechanical advantage of the scissors, and (ii) the load offered by the cloth.

(b) How does the pair of scissors atc : as a force multiplier or as a speed multiplier ?

Watch Video Solution

7. A 4 m long rod of negligible weight is supported at a point 125 cm from its one end and a load of 18 kgf is suspened at a point 60 cm from the support on the shorter arm.

(a) If a weight W is placed at a distance 250 cm from the support on the longer arm to balance the rod, find W.

(b) If a weight 5 kgf is kept to balance the rod, find its position.

(c) To which class of lever does it belong ?

Watch Video Solution

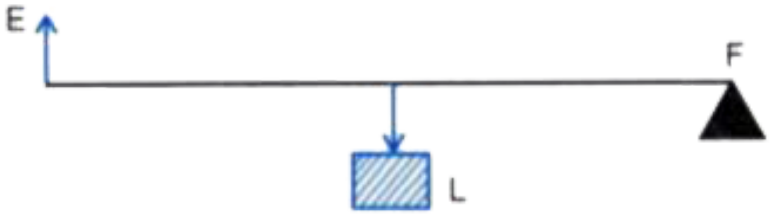
8. A lever of length 9 cm has its load arm 5 cm long and the effort arm is 9 cm long. (a) to which class does it belong ?

(b) Draw a diagram of the lever showing the position of the fulcrum F and directions of both the load L and effort E. (c) what is the mechanical advantage and velocity ratio if the efficiency is 100%?

(d) What will be the mechanical advantage and velocity ratio if the efficiency becomes 50%?

Watch Video Solution

9. Figure below shows a lever in use

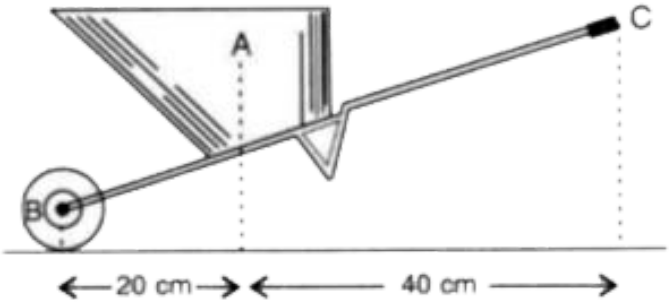


(a) To which class of levers does it belongs ?

(b) Without changing the dimensions of the lever, if the load is shifted towards the fulcrum what happens to the mechanical advantage of the lever ?

Watch Video Solution

10. Figure below shows a wheel barrow of mass 15 kg carrying a load of 30 kgf with its centre of gravity at A. the points B and C are the centre of wheel and tip of the handle such that the horizontal distance AB=20 cm and AC=40 cm.



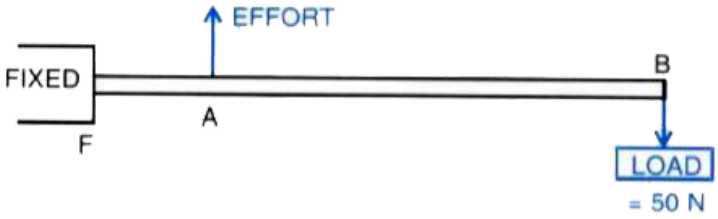
Find: (a) the load arm, (b) the effort arm,

(c) the mechanical advantage, and (d) the

minimum effort required to keep the leg just off the ground.

Watch Video Solution

11. Figure below shoes the use of a lever.



(a) State the principle of moments as applied to the above lever.

(b) To which class of lever does it belong ? Give an example of this class of lever.

(c) If FA=10 cm, AB=490 cm, calculate: (i) the mechanical advantage, and (ii) the minimum effort required to lift and load (=50N).

Watch Video Solution

12. A fire tongs has its arms 20 cm long. It is used to lift a coal of weight 1.5 kgf by applying an effort at a distance of 15 cm from the fulcrum. Find : (i) the mechanical advantage of the togns, and (ii) the effort needed.

Watch Video Solution

Exercise 3 B

1. What is a fixed pulley ? State its one use.

Watch Video Solution

2. What is the ideal mechanical advantage of a single fixed pulley ? Can it be used as a force multiplier?

Watch Video Solution

3. Name the pulley which has no gain in mechanical advantage. Explain, why is such a pulley then used ?

Watch Video Solution

4. What is the velocity ratio of a single fixed Pulley?

Watch Video Solution

5. In a single fixed pulley, if the effort moves by a distance x downwards, by what height is the load raised upwards ?

Watch Video Solution

6. What is a single movable pulley ? What is its mechanical advantage in the ideal case ?

Watch Video Solution

7. Name the type of a single pulley that has an ideal mechanical advantage equal to 2. draw a labelled diagram of the pulley mentioned by you.

Watch Video Solution

8. Give two reasons why the efficiency of a single movable pulley is not 100%.

Watch Video Solution

9. In which direction does the force need to be applied, when a single pulley is used with a mechanical advantage greater than 1 ? How can you change the direction of force applied without altering its mechanical advantage ? Draw a labelled diagram of the system.

Watch Video Solution

10. What is the velocity ratio of a single movable pulley ? How does the friction in the pulley bearing affect it ?

Watch Video Solution

11. In a single movable pulley, if the effort moves by a distance x upwards, by what height is the load raised ?

Watch Video Solution

12. Draw a labelled diagram of an arrangement of two pulleys, one fixed and other movable. In the diagram, mark the directions of all forces

acting on it. What is the ideal mechanical advantage of the system ? How can it be achieved ?

Watch Video Solution

13. The diagram alongside shows a pulley arrangement.

(a) Name the pulleys A and B.

(b) In the diagram, mark the direction of tension on each strand of string.

(c) What is the purpose of the pulley B?

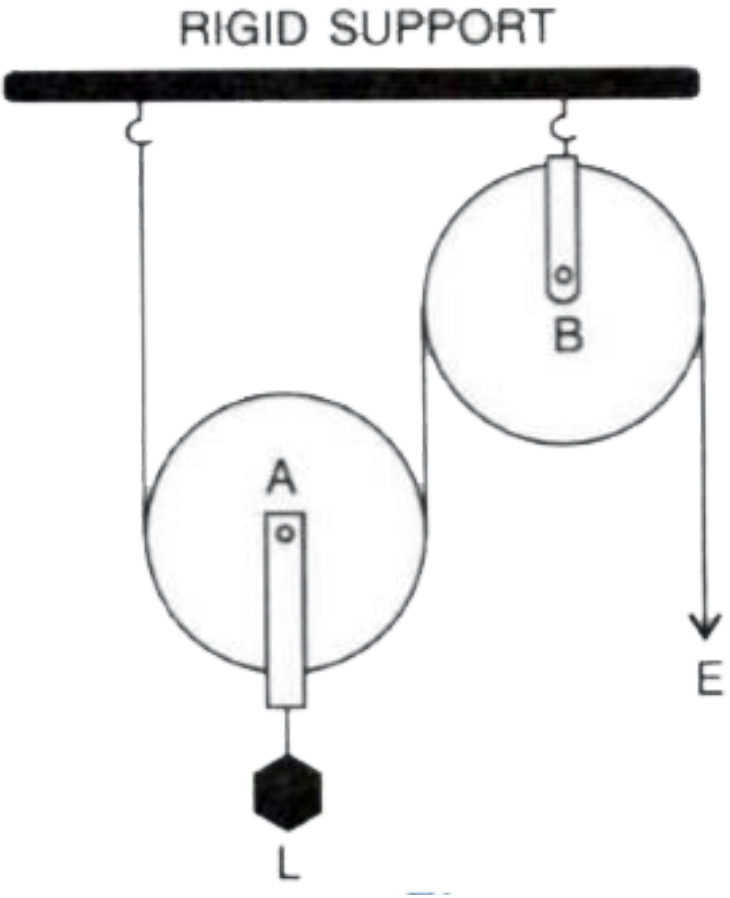
(d) If the tension is T, deduce the relation between

T and E

(e) What is the velocity ratio of the arrangement ?

(f) Assuming that the efficiency of the system

is 100%, what is the mechanical advantage ?

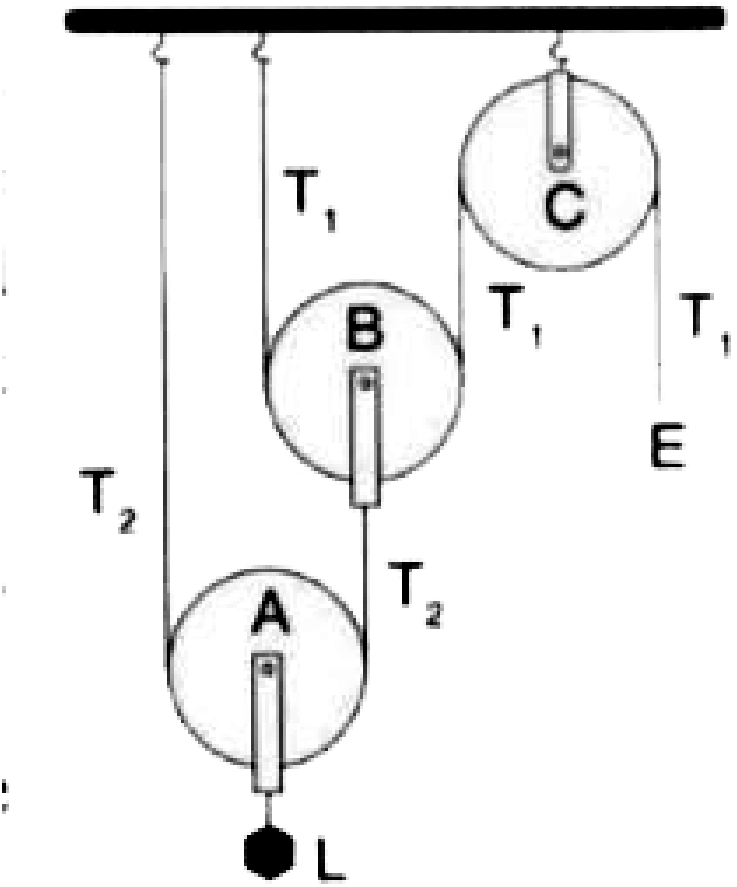


Watch Video Solution

14. State four differences between a single fixed pulley and a single movable pulley.

Watch Video Solution

15.



The diagram alongside shows an arrangement of three pulleys A,B and C. the load is marked as L and the effort as E.

(a) Name the pulleys A,B and C.

(b) Mark in the diagram the directions of load (L), effort (E) and tension T_1 and T_2 in the two strings.

(c) How are the magnitudes of L and E related to the tension T_1 ?

(d) Calculate mechanical advantage and velocity ratio of the arrangement.

(e) What assumptions have you made in parts (c) and (d) ?

Watch Video Solution

16. Draw a diagram of a combination of three movable pulleys and one fixed pulley to lift up a load. In the diagram, show the directions of load, effort and tension in each strand. Find : (i) the mechanical advantage, (ii) the velocity ratio, and (iii) the efficiency of the combination, in the ideal situation.

Watch Video Solution

17. Draw a diagram of a block and tackle system of pulleys having a velocity ratio of 5. in your diagram indicate clearly the points of application and the directions of the load L and effort E. also mark the tension T in each strand.

Watch Video Solution

18. Give reasons for the following:

(a) In a single fixed pulley, the velocity ratio is

always more than the mechanical advantage.

(b) The efficiency of a movable pulley is always less than 100%.

(c) In case of a block and tackle system, the mechanical advantage increases with the increase in the number of pulleys.

(d) The lower block of a block and tackle pulley system must be of negligible weight.

 Watch Video Solution

19. Name a machine which is used to :

(a) multiply force,

(ii) multiply speed, and

(c) change the direction of force applied.

Watch Video Solution

20. State whether the following statements are true or false by writing T or F.

(a) The velocity ratio of a single fixed pulley is always more than 1.

(b) The velocity ratio of a single movable pulley is always 2.

(c) The velocity ratio of a combination of n movable pulleys with a fixed pulley is always 2^n .

(d) The velocity ratio of a block and tackle system is always equal to the number of strands of the tackle supporting the load.

Watch Video Solution

Exercise 3 B Multiple Choice Type

1. A single fixed pulley is used because it:

A. has mechanical advantage greater than 1

B. has velocity ratio less than 1.

C. gives 100% efficiency

D. helps to apply the effort in a convenient direction

Answer: D

Watch Video Solution

2. The mechanical advantage of an ideal single movable pulley is:

A. 1

B. 2

C. less than 2

D. less than 1

Answer: B

Watch Video Solution

3. A movable pulley is used as:

A. a force multiplier

B. a speed multiplier

C. a device to change the direction of effort

D. an energy multiplier

Answer: A

Watch Video Solution

Exercise 3 B Numericals

1. A woman draws water from a well using a fixed pulley. The mass of bucket and water together is 6 kg. the force applied by the woman is 70 N. calculate the mechanical advantage. (Take g=$10ms^{-2}$)

Watch Video Solution

2. A fixed pulley is driven by a 100 kg mass falling at a rate of $8 \cdot 0$m in $4 \cdot 0s$. It lifts a load of $75 \cdot 0$ kgf. Calculate

(a) The power input to the pulley taking the

force of gravity on 1 kg as 10 N.

(b) the efficiency of the pulley, and

(c) The height to which the load is raised in $4 \cdot 0s$.

Watch Video Solution

3. A single fixed pulley and a movable pulley both are separately used to lift a load of 50 kgf to the same height. Compare the efforts applied

Watch Video Solution

4. In a block and tackle system consisting of 3 pulleys, a load of 75 kgf is raised with an effort of 25 kgf. Find : (i) the mechanical advantage, (ii) the velocity ratio, and (iii) the efficiency.

Watch Video Solution

5. A block and tackle system has 5 pulleys. If an effort of 1000 N is needed in downward direction to raise a load of 4500 N, calculate:

(a) the mechanical advantage,

(b) the velocity ratio, and

(c) the efficiency of the system

Watch Video Solution

6. In Figure, draw a tackle to lift the load by applying the force in downward direction.

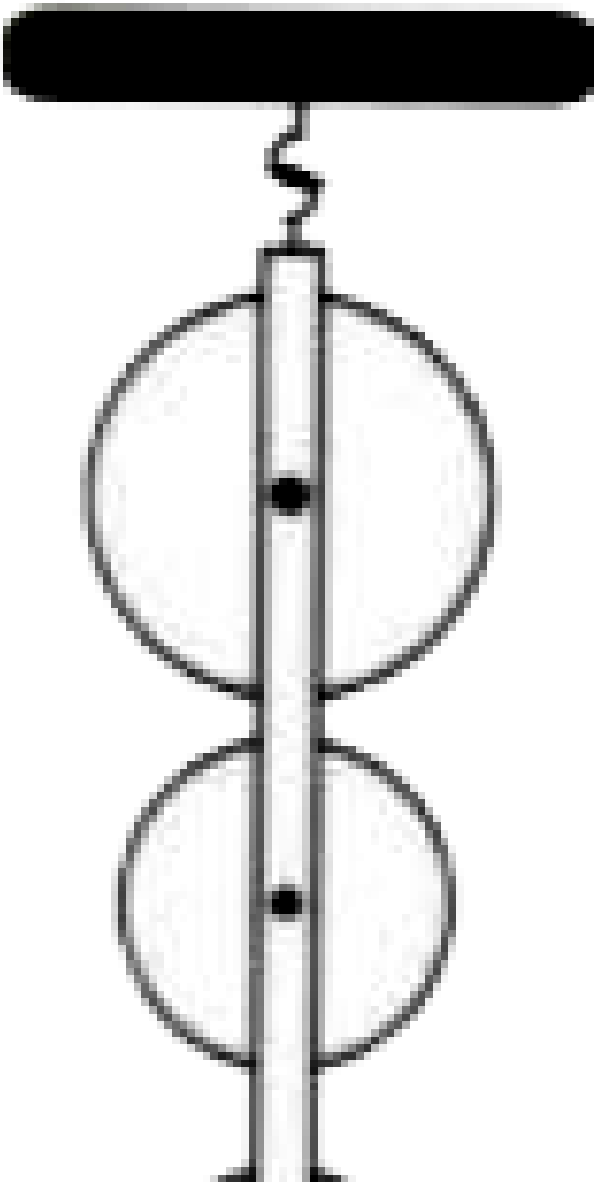
(a) Mark in the diagram the direction of load L and effort E.

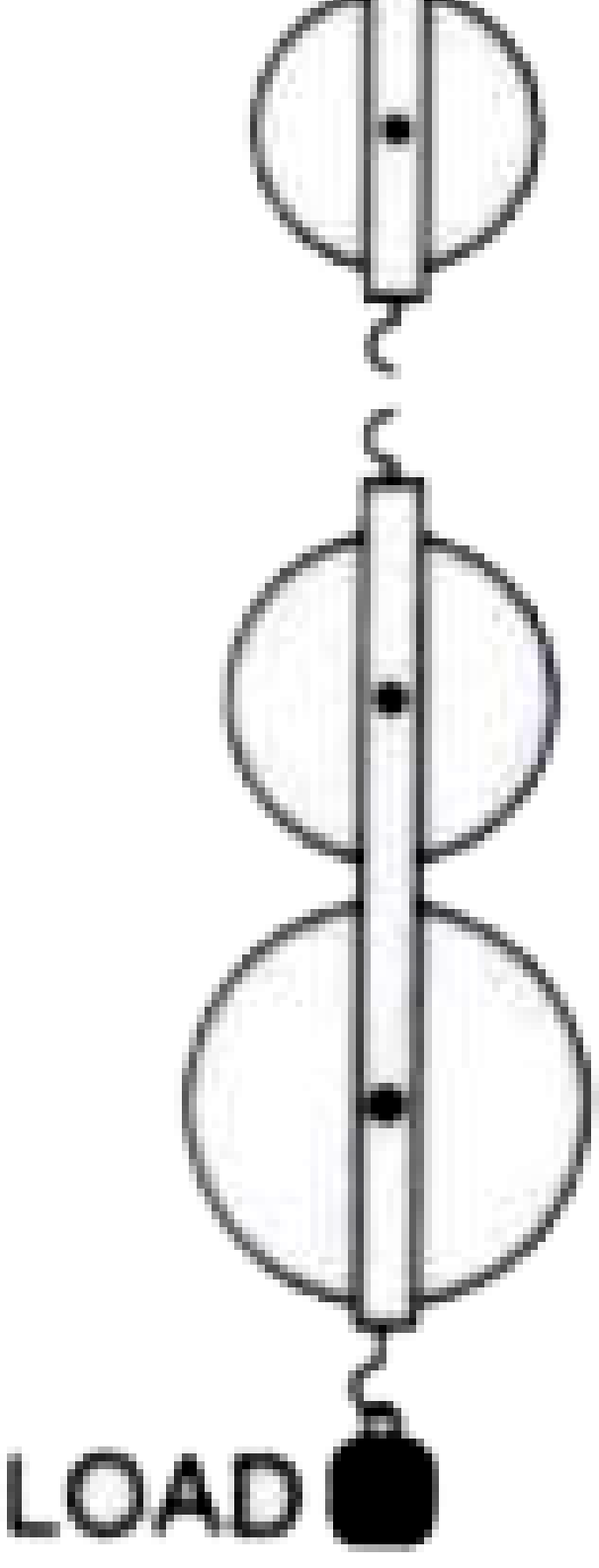
(b) If the load is raised by 1 m, through what distance will the effot move ?

(c) State the number of strands of tackle

supporting the load.

(d) What is the mechanical advantage of the system?

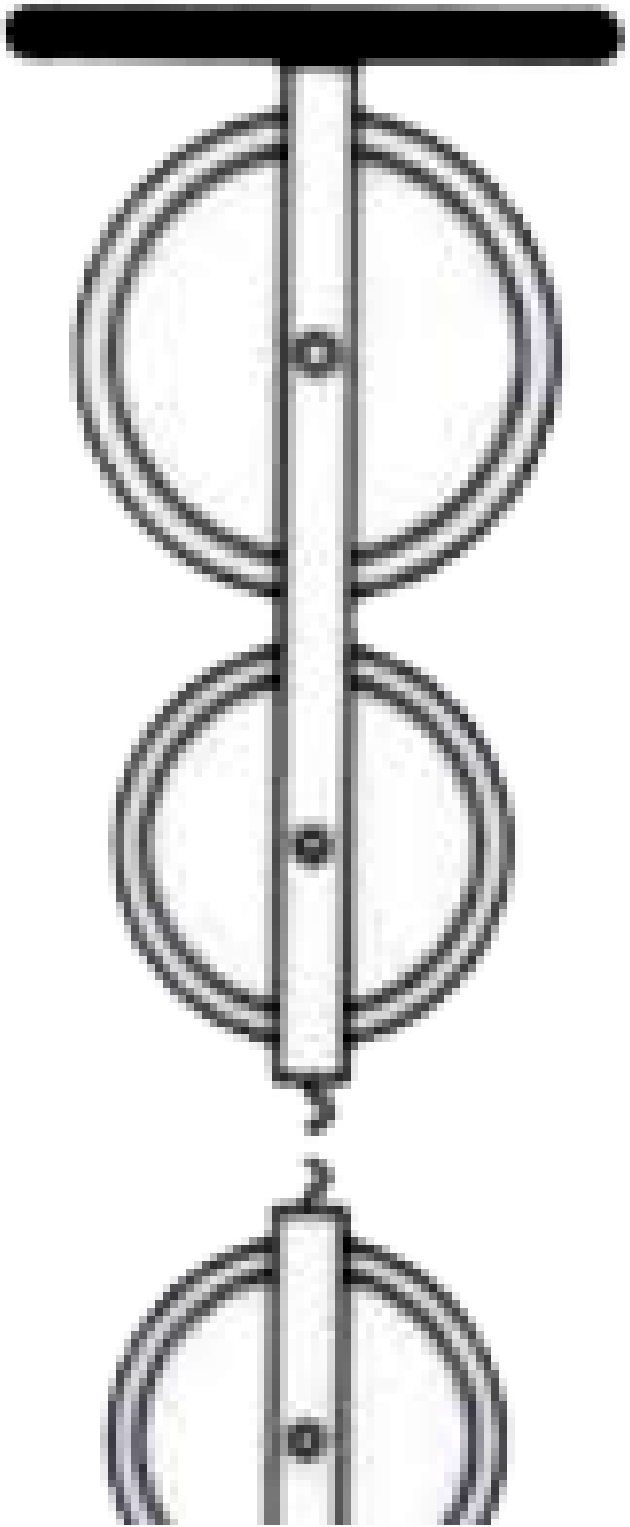


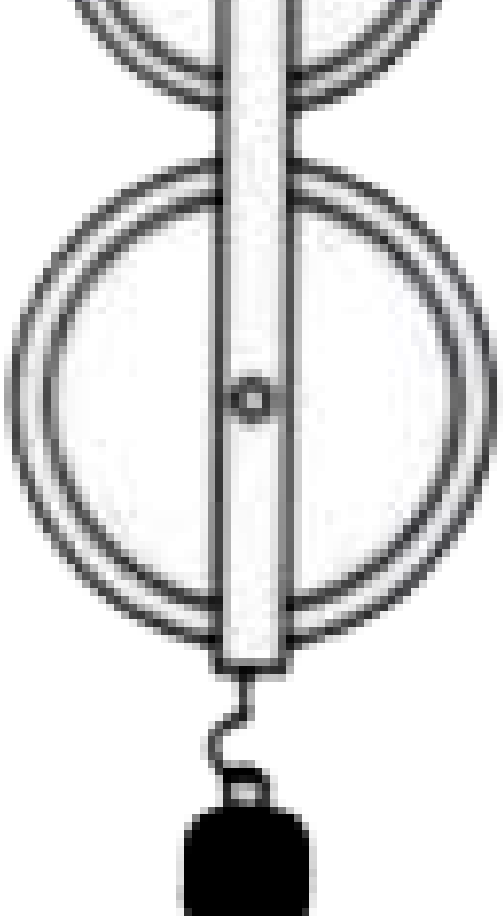

LOAD

Watch Video Solution

7. A pulley system has a velocity ratio 3. draw a diagram showing the point of applicationi and direction of load (L), effort (E) and tension (T). It lifts a load of 150 N by an effot of 60 N. calculate its mechanical advantage. Is the pulley system ideal ? Give reason.

Watch Video Solution





8.

Figure shows a system of four pulleys. The upper two pulleys are fixed and the lower two are movable.

(a) Draw a string around the pulleys.

Also show the point of application and

direction in which the effort E is applied.

(b) What is the velocity ratio of the system ?

(c) How are load and effort of the pulley system related ?

(d) What assumption do you make in arriving at your answer in part (c) ?

Watch Video Solution

9. Figure shows a block and tackle system of pulleys used to lift a load.

(a) How many strands of tackle are supporting

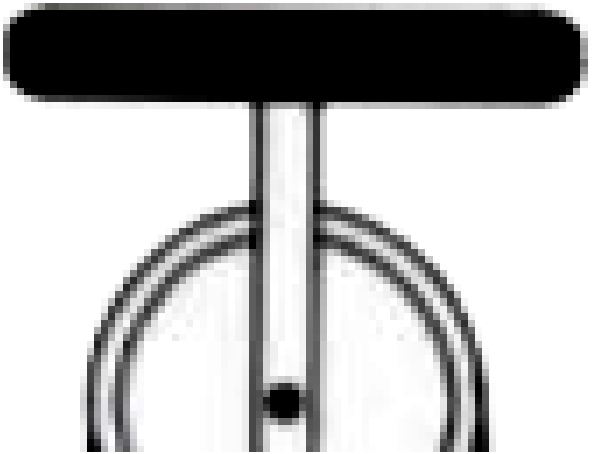
the load ?

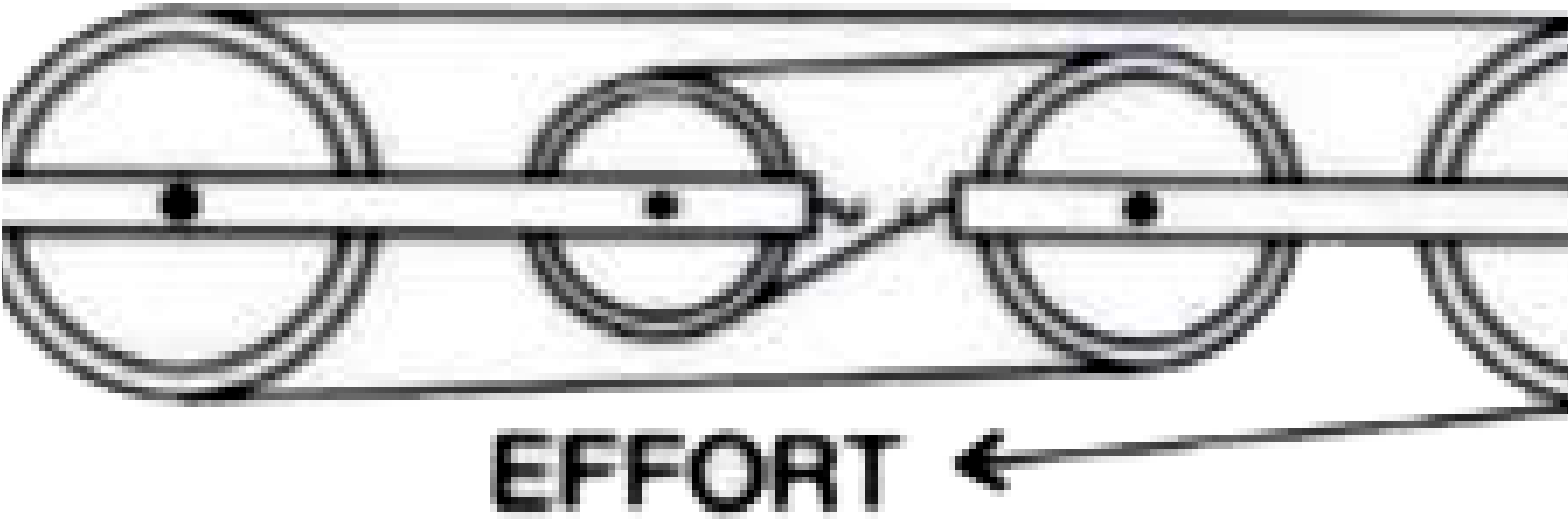
(b) Draw arrows to represent tension T in each strand.

(c) What is the mechanical advantage of the system?

(d) When load is pulled up by a distance 1 m, how far does the effort end move ?

(e) How much effort is needed to lift a load of 100 N?




EFFORT

Watch Video Solution

10. A block and tackle system has velocity ratio 3. draw a labelled diagram of the system indicating the points of application and the direction of load L and effort E. A man can exert a pull of 200 kgf. (a) What is the maximum load he can raise with this pulley

system if its efficiency is 60% ? (b) if the effort end moves a distance 60 cm, what distance does the load move ?

Watch Video Solution

11. You are given four pulleys and three strings. Draw a neat and labelled diagram to use them so as to obtain a maximum mechanical advantage equal to 8. In your diagram mark the directions of load L, effort E and tension in each strand.

What assumptions have you made to Obtain the required mechanical advantage ?

Watch Video Solution