Simple Machines

Make _____ easier

Does not change the amount of _____ done, does change the _____ required.

Less force means moves over more _____
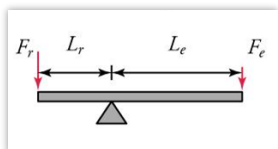

Ideal Mechanical Advantage

The ratio of how much the simple machine multiplies the _____ force (F_e) into the _____ force (F_r) required force to do work

$$IMA = \frac{F_r}{F_e} = \frac{d_e}{d_r}$$

Lever

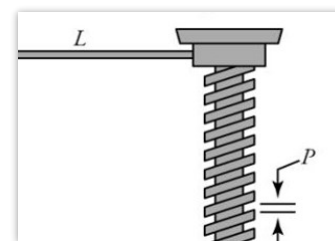The rotation point is called the _____
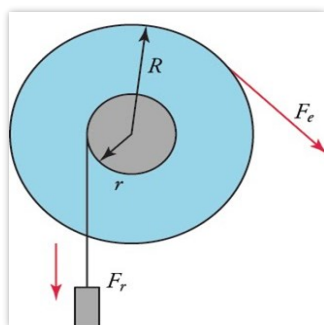
$$IMA = \frac{L_e}{L_r}$$

Wheel and Axle

_____ where effort arm can _____ completely around the fulcrum

d_e is the radius of the _____ R

d_r is the radius of the _____ r

$$IMA = \frac{R}{r}$$

Inclined Plane

_____ surface

d_e = _____

d_r = _____

$$IMA = \frac{L}{h}$$

Wedge

Two _____ _____ put together

d_e = _____

d_r = _____

$$IMA = \frac{L}{t}$$

Screw

_____ _____ wrapped around a _____ _____

d_e = radius of _____

$(2\pi L)d_r$ = distance between _____ (pitch, p)

$$IMA = \frac{2\pi L}{P}$$
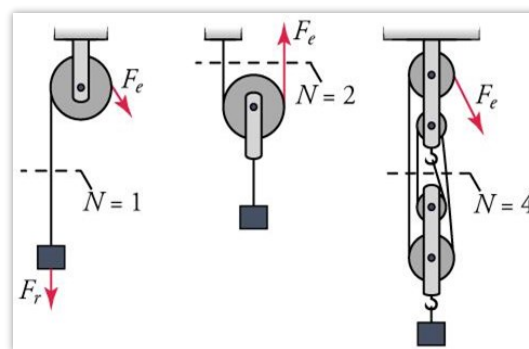
Pulley

Rope wrapped around a _____ _____

d_e = distance the _____ is pulled

d_r = distance the _____ is lifted

When a 2nd rope supports the weight, then the distance it travels is _____

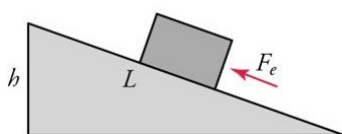IMA = number of _____ supporting the weight

$$IMA = N$$
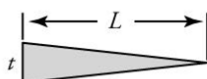
Find the ideal mechanical advantage of a ramp of length 10 m and height 3 m.

Find the ideal mechanical advantage of a 3 m lever whose fulcrum is 50 cm from one end with the load.

What is the ideal mechanical advantage of a pulley that is supporting the load by 4 ropes?

How much rope needs to be pulled to lift the load 2 m?

If the load's mass is 120 kg, how much force is required to lift the load?

Efficiency

Useful energy output is always _____ than energy or work _____

$$Efficiency\ (Eff) = \frac{\text{useful energy or work output}}{\text{total energy or work input}} \times 100\% = \frac{W_{out}}{W_{in}} \times 100\%$$

The actual efficiency of a screw is 94%. The screwdriver handle has a radius of 1.25 cm, and the screw has a pitch of 1 mm and radius of 1.2 mm. If it takes 9 N of force on the screwdriver to screw it in, what is the frictional force resisting the screw?

Practice Work

1. How does a simple machine make work easier?

2. Which type of simple machine is a knife?

3. Why are machines not 100% efficient?

4. What is the IMA of a wedge that is 12 cm long and 3 cm thick? (OpenStaxHS 9.31) **4**

5. What is the IMA of a 3-m lever where the fulcrum is at one end and the load is 40 cm from the fulcrum (like a wheelbarrow)? (RW) **7.5**

6. A pulley system requires a person to pull down 20 m of rope to lift a 500 kg go kart 4 m. (a) What is the mechanical advantage of the pulley system? (b) How many ropes support the load? (c) What effort force is required to lift the go kart? (RW) **5; 5; 980 N**

7. The axle for a 2003 Kia Rio is 73.5 mm in diameter. The tire's diameter is 583 mm. (a) What is the mechanical advantage of this wheel and axle? (b) If the input force is 3840 N, what is the ideal resistive force? (c) If the resistive force is actually 21400 N, what is the size of the friction force? (RW) **7.93; 30500 N; 9100 N**

8. A man is using a wedge to split a block of wood by hitting the wedge with a hammer. This drives the wedge into the wood creating a crack in the wood. When he hits the wedge with a force of 400 N it travels 4 cm into the wood. This caused the wedge to exert a force of 1,400 N sideways increasing the width of the crack by 1 cm. What is the efficiency of the wedge? (OpenStaxHS 9.19) **87.5%**

9. An access ramp to a building needs to rise 1.5 m from the ground to the door. (a) If the mechanical advantage is 3, what length of ramp is needed? (b) A 70-kg person is pushed up the ramp in a wheelchair. What is the ideal force required to push it up? (c) If the efficiency is 98% due to friction, what is the actual force required to push the person up the ramp? (RW) **4.5 m; 229 N; 233 N**

10. A screwdriver handle has a diameter of 2.25 cm. The screw has an ideal mechanical advantage of 40. (a) What is the pitch of the screw? (b) If 13 N is used to turn the screwdriver, what force is used to drive the screw into the wood? (c) If the actual resistive force is 470 N, how much energy is converted to heat by friction? (RW) **1.77 mm; 520 N; 0.0884 J**