Date:
Page:

Simple machine

1a Tick (✓) the best answer

a. What is the mechanical advantage of a single fixed pulley?
i. 1 ✓ ii. 2 iii. 0 iv. 3

b. Which of the following is not affected by friction?
i. MA ii. VR ✓ iii. Efficiency iv. All of them

c. Which of the following gives velocity ratio of an inclined plane?
i. Y/R ii. L/E iii. R/Y iv. 1/h ✓

d. If MA and VR of simple machine have same value, what kind of machine is it?
→ i. Practical machine ii. Light machine iii. Perfect machine ✓ iv. Sewing machine

e. Which of the following is an example of inclined plane?
i. Ramp ✓ ii. Car jack iii. Axe iv. Plane

2 write down difference between

a) Input work and output work

Input work	output work
→ It is the work done on the machine by the user.	→ It is the work done by the machine on the load
→ It is given by :- Input work = Effort x Effort distance	→ It is given by output work = Load x Load distance

b) Screw and wedge

Screw	wedge
i) Screw is a simple machine formed by Spiral winding of inclined plane around a cylindrical surface	i) wedge is a simple machine formed by combination of two inclined planes to make sharp surfaces.
ii. It is used to hold objects or lift things.	ii. It is mainly used for cutting, splitting and breaking objects

Date:
Page:

c) Pulley and wheel and axle

Pulley	Wheel and axle
i. A pulley is a hard metallic or wooden disc with a groove along circumference for a rope.	i. A wheel and axle is a simple machine made up of ~~two~~ wheel connected to a smaller axle.
ii. It changes direction of force as well as multiplies force.	ii. It only multiplies force or speed.

d) Jack screw and car jack

Jack screw	Car jack
→ Jack screw is a simple machine that uses a screw to lift heavy loads.	→ Car jack is a complex machine that is used to lift a car for repairs.
→ It works by rotating screw.	→ It is a device which may use hydraulic, screw or scissor.

Date:
Page:

3. Give reasons

a. The velocity ratio of movable pulley is 2.
→ It is because ~~for~~ in movable pulley load is supported by two rope segments, so we have to pull 2 metres of rope to lift load by 1 metre.

b. Mechanical advantage of a simple machine is always less than velocity ratio.
→ It is because of the friction and energy loss in the real machines, since mechanical advantage is affected by friction whereas, VR isn't so, mechanical advantage is less than velocity ratio in simple machine.

c. Efficiency of simple machine can never be 100%.
→ It is because some energy is always lost due to friction, but for simple machine to be 100% input work should be equal output work.

d. Wheel and axle is also known as continous lever.
→ It is because it works similar to lever that rotates ~~cont~~ continously around a fixed point.

e. Roads are made winding in hilly ~~reasons~~ regions.
→ Roads are made winding in hilly regions because it reduces the slopes of roads which makes easier for vehicles to climb and travel safer.

f. Sewing machine is a complex machine

→ Sewing machine is a complex machine because it is made by combining many simple machines like levers, wheels, wheel and axle, etc.

5a. Solve the following numerical problems

a. In a first class lever of length 1m, a pivot is placed at a distance of 20cm from a load of 600N. If the effort used is 300N calculate

i) MA ii) VR iii) Efficiency

a) Soln

Given,

length of lever $(l) = 1m$

Load distance $(ld) = 20cm = 0.2m$

Effort applied $(E) = 300N$

Effort distance $(Ed) = l - ld = 1 - 0.2 = 0.8m$

Load $(L) = 600N$

Now

i) $$MA = \frac{L}{E} = \frac{600}{300} = 2$$

ii) $$VR = \frac{Ed}{ld} = \frac{0.8}{0.2} = 4$$

Date:
Page:

efficiency = $\frac{\text{output work}}{\text{Input work}} \times 100\%$

$= \frac{L \times l\,d}{E \times E\,d} \times 100\%$

$= \frac{600 \times 0.2}{900 \times 0.8} \times 100\%$

$= \frac{2}{4} \times 100\%$

$= 50\%$

b. A block and tackle consisting of 6 pulleys is used to lift a load of 300N with an effort of 75N. Calculate mA, VR and efficiency of machine

->

Sol-n

Given

no of pulley $(n) = 6$

Load $(L) = 300\,N$

Effort $(E) = 75\,N$

Now,

$mA = \frac{L}{E} = \frac{300}{75} = 4$

VR = no. of pulley used = 6

efficiency = $\frac{mA}{VR} \times 100\%$

$= \frac{4}{6} \times 100\%$

$= \frac{400}{6}\%$

$= 66.67\%$

c. A truck of mass 10,000kg is moving through a sloppy road of length 20km with the help of 5000N force. If the truck climbs vertical height of 200m and its efficiency is 80%. Calculate the additional mass that can be carried by the truck.

Soln

Given Effort (E) = 5000N
mass of truck (m_t) = 10,000kg
length of sloppy road (l) = 20km = 20,000m
vertical height (h) = 200m
efficiency (η) = 80%.
additional mass (m_a) = ?

Now,
Input work = Effort × l
= 5000 × 20,000
= 100000000 J
= 1×10^8 J

we know

$$\eta = \frac{W_{out}}{W_{in}} \times 100\%$$

$$\frac{80}{100} = \frac{W_{out}}{1 \times 10^8 J}$$

$$0.8 \times 1 \times 10^8 = W_{out}$$

$$0.8 \times 10^8 J = W_{out}$$

$$8 \times 10^7 J = W_{out}$$

Now,

$$W_{truck} = mtruck \times g \times h$$

$$= 10{,}000 kg \times 10 \times 200 m$$

$$= 2.0 \times 10^7 J$$

Remaining work for additional load.

$$\text{output work} - W_{truck} = 8.0 \times 10^7 J - 2.0 \times 10^7 J$$

$$W_{rem} = 6 \times 10^7 J$$

Now,

Additional mass $= \frac{W_{rem}}{gh}$

$$= \frac{6 \times 10^7 kg}{10 \times 200 m} = 30{,}000 kg$$

Date:

Page:

d. A wheel and axle arrangement having the wheel of radius 20cm and the axle with radius 10cm can lift a load of 150N with and effort of 90N. Calculate MA, VR and η

Soln

Given

Radius of wheel $(R) = 20cm$

Radius of axle $(r) = 10cm$

Load lifted $(L) = 150N$

Effort applied $(E) = 90N$

MA, VR and η $= ?$

Now,

we know

$$MA = \frac{L}{E} = \frac{150}{90} = \frac{5}{3} = 1.67$$

$$VR = \frac{R}{r} = \frac{20}{10} = 2$$

$$\eta = \frac{MA}{VR} \times 100\%$$

$$= \frac{1.67}{2} \times 100\%$$

$$= 83.5\%$$

Date:
Page:

e. If a lever lifts a load four times effort applied and Effort distance is 5 times load distance. Calculate its efficiency.

Soln

Given,

Load (L) = 4 X Effort (E)

Effort distance (Ed) = 5x load distance (Ld)

Efficiency (η) = ?

Now,

we Know that,

$$\eta = \frac{L \times Ld}{E \times Ed} \times 100\%$$

$$= \frac{4E}{E} \times \frac{Ld}{5 \times Ld} \times 100\%$$

$$= \frac{4}{5} \times 100\%$$

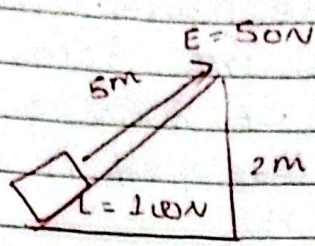
$$\eta = 80\%$$

f.

Date:

Page:

f. Calculate value of mA, VR and η from diagram.



Soln

Given,

Length of inclined plane (l) = 5m

height of inclined plane (h) = 2m

Effort applied on load (E) = 50N

Load (L) = 100N

mA, VR and η = ?

Now,

we know, of Inclined plane.

$$mA = \frac{L}{E} = \frac{100}{50} = 2$$

$$VR = \frac{l}{h} = \frac{5}{2} = 2.5$$

$$\eta = \frac{mA}{VR} \times 100\%$$

$$= \frac{2}{2.5} \times 100\%$$

$$= 80\%$$

Date:
Page:

9. ~~The~~ A wedge cutting a wooden log is shown in the figure. The width and depth of a wedge are 6cm and 12cm respectively. If an effort of 300N is applied, a resistance of 500N is developed in the wedge. Calculate MA, VR and η

Soln

Given

Effort applied $(E) = 300N$

Resistance $(W) = 500N$

width of wedge $(L) = 6cm$

(depth) Length of wedge $(H) = 12cm$

MA, VR and η $= ?$

Now,

we know that for wedge,

$$MA = \frac{W}{E} = \frac{500}{300N} = 1.67$$

$$VR = \frac{H}{L} = \frac{12}{6} = 2$$

$$\eta = \frac{MA}{VR} \times 100\%$$

$$= \frac{1.67}{2} \times 100\%$$

$$= 83.5\%$$