GIVE FEEDBACK

CONTINUE >

Mechanical drives are devices that are designed to continuously transmit power via rotating components.

Examples of mechanical drives include gearboxes, belt drives and chain drives.

In this section we consider the transmitted torque and power for these mechanical drives along with the efficiency of the unit.

Mechanical drive

Mechanical drives are devices, such as gearboxes and belt or chain drives, used for the purpose of mechanical power transmission.

Unlike simple machines, whose action is usually intermittent, mechanical drives are designed for continuous operation involving rotating components.

All mechanical drives have an input side and an output side, usually involving a rotating shaft, sprocket or pulley on each side.

GIVE FEEDBACK

OK

Which of the following are examples of mechanical drives?

Check all that apply.

- [ ] Truck gearbox
- [ ] Bicycle chain and sprockets
- [ ] Crowbar
- [ ] Belt-driven cooling fan
- [ ] Weston differential chain block
- [ ] Loading ramp

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Type your answer in the box.

The action of simple machines is usually [ ]; mechanical drives are designed for [ ] operation involving rotating components.

All mechanical drives have an input side and an [ ] side, usually involving a [ ] shaft, sprocket or pulley on each side.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

The action of simple machines is usually Select... ; mechanical drives are designed for Select... operation involving rotating components.

All mechanical drives have an input side and an Select... side, usually involving a Select... shaft, sprocket or pulley on each side.

Submit

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Transmission of power by a mechanical drive

Transmission of power by mechanical drives is often associated with changes in the speed or direction of rotational motion of mechanical components.

Some of the fundamental principles of simple machines, such as efficiency and velocity ratio, are also applicable to the study of mechanical drives.

<

However, in the case of mechanical drives, instead of work done it is usually more convenient to refer to power transmitted (i.e. time rate of doing work).

<

GIVE FEEDBACK

OK

Which of the following are correct statements about the transmission of power by mechanical drives?

Check all that apply.

- [ ] Transmission of power is often associated with changes in the speed or direction of rotational motion of mechanical components
- [ ] During analysis of the machine it is usually more convenient to refer to power transmitted
- [ ] Transmission of power never involves changes in the speed or direction of rotational motion of mechanical components
- [ ] During analysis of the machine it is always less convenient to refer to power transmitted
- [ ] Efficiency and velocity ratio are never applicable

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

An example of input torque is the torque applied to a bicycle sprocket by the rider pushing on the pedals.

Input torque

The torque exerted on the drive on the input, or driver, side is called the **input torque**, T_{in}.

GIVE FEEDBACK

OK

Type your answer in the box.

The torque exerted on the driver side of a mechanical drive is called the _____ torque.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

An example of output torque is the torque applied to the rear wheel of a bicycle by the chain.

Output torque

The torque transmitted by the drive to its output side is called the **output torque**, T_{out}.

GIVE FEEDBACK

OK

Type your answer in the box.

The torque transmitted by the mechanical drive to its driven side is called the _____ torque.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Mechanical power

Mechanical power is the rate of doing mechanical work.

For a rotating component the work is done by the torque moving through an angular distance.

Therefore the mechanical power for a rotating component is equal to the rate at which the torque moves through an angular distance, i.e. the torque multiplied by the angular speed.

GIVE FEEDBACK

OK

Type your answer in the box.

Mechanical power is the _____ of doing mechanical work.

For a rotating component the work is done by the _____ moving through an angular distance.

Therefore the mechanical _____ for a rotating component is equal to the rate at which the torque moves through an angular distance, i.e. the torque multiplied by the angular speed.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Calculating mechanical power with continuous rotation of a component

Mechanical power associated with continuous rotation of a component is given by the equation below.

$$P = T\,\omega$$
$$= \frac{2\pi NT}{60}$$

where:

P is power in W

T is torque in N.m

ω is rotational speed in rad/s

N is speed in rpm

Note that in order for this equation to produce accurate results the quantities must be entered in the correct units, as shown above.

GIVE FEEDBACK

OK

Which of the following is the correct equation for the mechanical power associated with continuous rotation of a component?

Click the correct answer.

$$P = \frac{2\pi NT}{60}$$

$$P = \frac{2\pi\omega T}{60}$$

$$P = \frac{2\pi N\omega}{60}$$

$$P = \frac{2\pi + T}{60}$$

$$P = \frac{\pi NT}{120}$$

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Match each of the symbols from the equation $P = \frac{2\pi NT}{60}$ with the correct description.

Drag statements on the right to match the left.

P	The power in watts
N	The rotational speed in rpm
T	The torque in Nm

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Drive efficiency

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

If the input and output power are calculated using the corresponding values of torque and speed, **drive efficiency** can be defined as the ratio of output power (P_{out}) to input power (P_{In}).

That is, efficiency = output/input.

To obtain a percentage efficiency, use the equation: efficiency = (output/input) x 100.

GIVE FEEDBACK

OK

Which of the following is a correct description of drive efficiency?

Click the correct answer.

- The ratio of output power to input power
- The sum of output power and input power
- The difference between input power and output power
- The ratio of input power to output power
- Output power multiplied by input power
- The difference between output power and input power

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Calculating efficiency of the device given the input and output power

The drive efficiency can be calculated using the equation below.

$$\eta = \frac{P_{out}}{P_{in}}$$

where:

η is the efficiency

P_{out} is the output power

P_{in} is the input power

The efficiency can be written as a percentage using:

$$\eta\% = \eta \cdot 100$$

GIVE FEEDBACK

OK

Which of the following is the correct equation for drive efficiency?

Click the correct answer.

$$\eta = \frac{P_{out}}{P_{in}}$$

$$\eta = \frac{P_{in}}{P_{out}}$$

$$\eta = P_{out} + P_{in}$$

$$\eta = P_{out} - P_{in}$$

$$\eta = P_{in} - P_{out}$$

$$\eta = P_{out} \cdot P_{in}$$

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Match each of the symbols from the equation $\eta = \frac{P_{out}}{P_{in}}$ with the correct description.

Drag statements on the right to match the left.

η	Drive efficiency
P_{out}	Output power
P_{in}	Input power

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Calculate mechanical power of a device

The input shaft of a gearbox rotates at 1450 rpm and transmits a torque of 65.9 N.m.

The output shaft rotates at 500 rpm and transmits a torque of 143.3 N.m.

Determine the input power and output power of the device.

Example	Input power	Output power

GIVE FEEDBACK

OK

Calculate mechanical power of a device

Input power:

$$P_{\text{in}} = \frac{2\pi NT}{60}$$
$$= \frac{(2)(\pi)(1{,}450)(65.9)}{60}$$
$$= 10\ \text{kW}$$

Example	Input power	Output power

GIVE FEEDBACK

OK

Calculate mechanical power of a device

Output power:

$$P_{out} = \frac{2\pi NT}{60}$$
$$= \frac{(2)(\pi)(500)(143.3)}{60}$$
$$= 7.5 \text{ kW}$$

Example	Input power	Output power

GIVE FEEDBACK

OK

Calculate the input power (correct to the nearest watt).

Clear

Clear line

?

Undo

Click and type your answer here

CHALLENGE

SUBMIT

SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

Hint

Each hint will reduce the credit received for this question

Calculate the output power (correct to the nearest watt).

Clear

Clear line

? Undo

Click and type your answer here

CHALLENGE SUBMIT SHOW ANSWER

INSTRUCTIONS

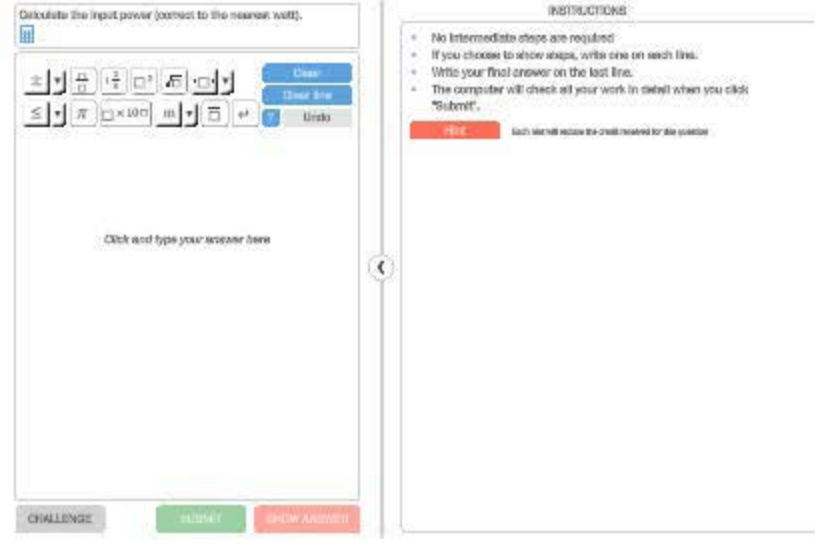
- No intermediate steps are required
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

Hint Each hint will reduce the credit received for this question

The input shaft of a gearbox rotates at 1000 rpm and transmits a torque of 120 N.m.

The output shaft rotates at 600 rpm and transmits a torque of 158 N.m.

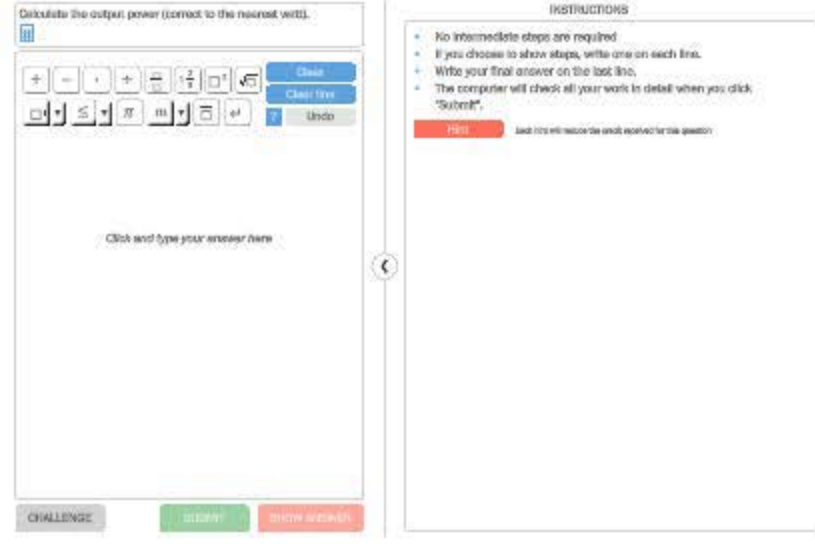
SMALL | MEDIUM | LARGE



The input shaft of a gearbox rotates at 1000 rpm and transmits a torque of 120 N.m.

The output shaft rotates at 600 rpm and transmits a torque of 158 N.m.

SMALL MEDIUM LARGE



Calculate the input power (correct to the nearest watt).

Clear

Clear line

Undo

Click and type your answer here

CHALLENGE

SUBMIT

SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

Hint

Each hint will reduce the credit received for this question

Calculate the output power (correct to the nearest watt).

Clear

Clear line

Undo

Click and type your answer here

CHALLENGE

SUBMIT

SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

Hint

Each hint will reduce the credit received for this question

The input shaft of a gearbox rotates at 4000 rpm and transmits a torque of 220 N.m.

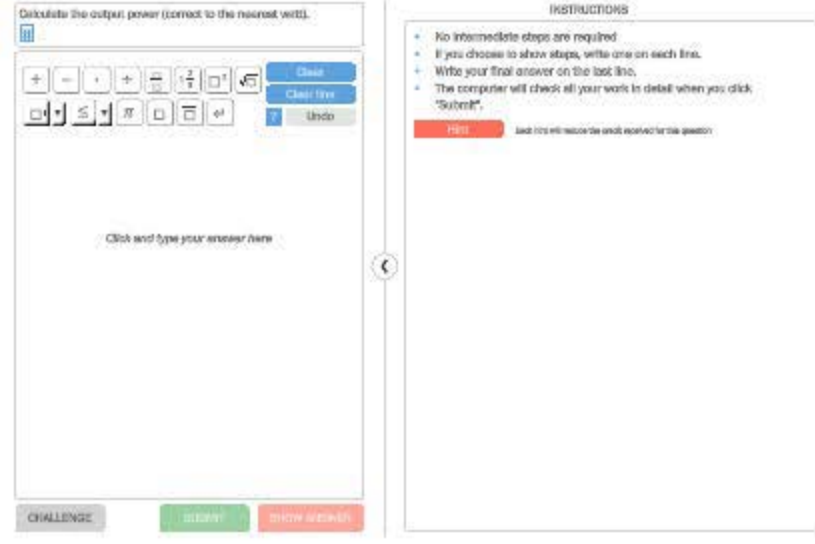
The output shaft rotates at 1200 rpm and transmits a torque of 498 N.m.

SMALL MEDIUM LARGE

The input shaft of a gearbox rotates at 4000 rpm and transmits a torque of 220 N.m.

The output shaft rotates at 1200 rpm and transmits a torque of 498 N.m.

SMALL | MEDIUM | LARGE



Calculate efficiency of a device

The input shaft of a gearbox rotates at 1450 rpm and transmits a torque of 65.9 N.m.

The output shaft rotates at 500 rpm and transmits a torque of 143.3 N.m.

Determine the efficiency of the device.

Example	Input power	Output power	Efficiency

GIVE FEEDBACK

OK

Calculate efficiency of a device

Input power:

$$P_{in} = \frac{2\pi NT}{60}$$
$$= \frac{(2)(\pi)(1{,}450)(65.9)}{60}$$
$$= 10\ \text{kW}$$

Example	Input power	Output power	Efficiency

GIVE FEEDBACK

OK

Calculate efficiency of a device

Output power:

$$P_{out} = \frac{2\pi NT}{60}$$
$$= \frac{(2)(\pi)(500)(143.3)}{60}$$
$$= 7.5\ \text{kW}$$

Example	Input power	Output power	Efficiency

GIVE FEEDBACK

OK

Calculate efficiency of a device

Efficiency:

$$\eta = \frac{P_{out}}{P_{in}}$$
$$= \frac{7.5\ \text{kW}}{10\ \text{kW}}$$
$$= 0.75$$
$$= 75\%$$

Example	Input power	Output power	Efficiency

GIVE FEEDBACK

OK

Given the input power is 12,566 W and the output power is 9,927 W, calculate the efficiency of the device. (Answer as a percentage correct to one decimal place.)

Clear

Clear line

Undo

Click and type your answer here. Show your work.

CHALLENGE

SUBMIT

SHOW ANSWER

INSTRUCTIONS

- You must show intermediate steps for full credit, one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

Hint

Each hint will reduce the credit received for this question

Calculate the efficiency of the device. (Answer as a percentage correct to one decimal place.)

Clear

Clear line

Undo

Click and type your answer here

CHALLENGE

SUBMIT

SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

Hint

Each hint will reduce the credit received for this question

The input shaft of a gearbox rotates at 4000 rpm and transmits a torque of 220 N.m.

The output shaft rotates at 1200 rpm and transmits a torque of 498 N.m.

SMALL MEDIUM LARGE

Type your answer in the box.

The input power is _____ W (correct to the nearest watt).

The output power is _____ W (correct to the nearest watt).

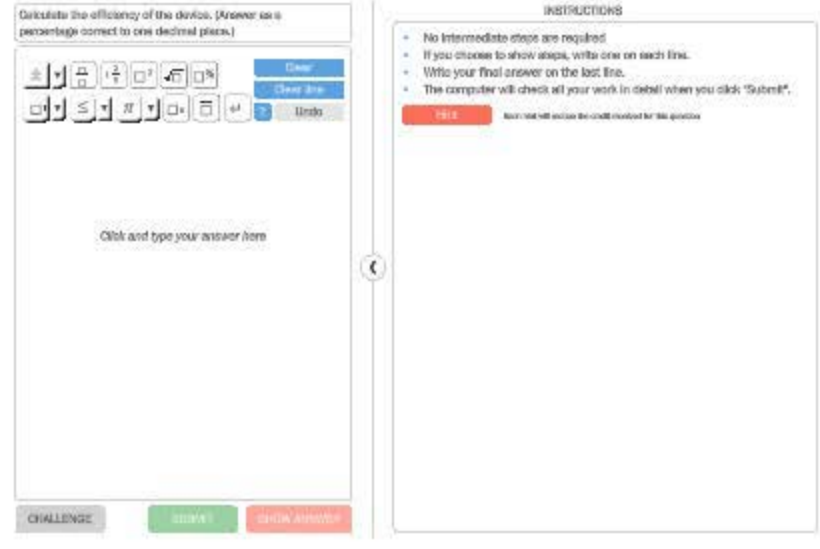
Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

The input shaft of a gearbox rotates at 4000 rpm and transmits a torque of 220 N.m.

The output shaft rotates at 1200 rpm and transmits a torque of 498 N.m.

SMALL MEDIUM LARGE



The input shaft of a gearbox rotates at 1000 rpm and transmits a torque of 120 N.m.

The output shaft rotates at 600 rpm and transmits a torque of 158 N.m.

SMALL MEDIUM LARGE

Type your answer in the box.

The input power is _____ W (correct to the nearest watt).

The output power is _____ W (correct to the nearest watt).

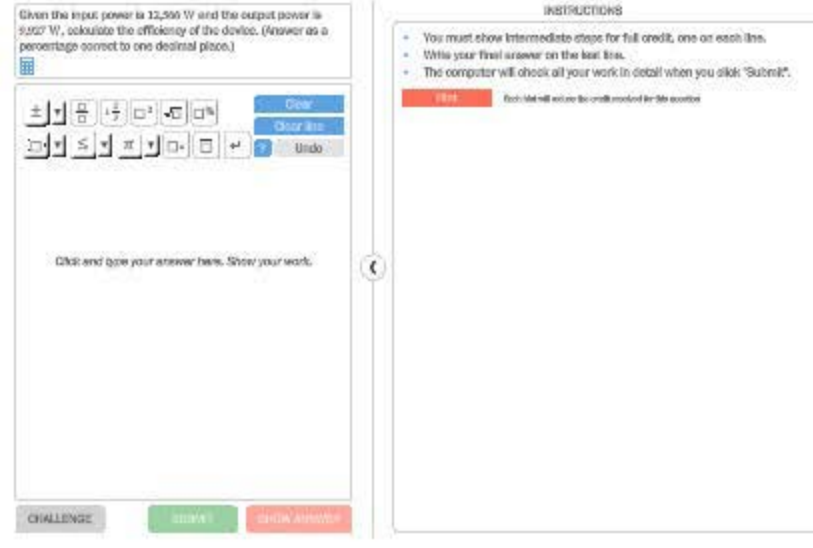
Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

The input shaft of a gearbox rotates at 1000 rpm and transmits a torque of 120 N.m.

The output shaft rotates at 600 rpm and transmits a torque of 158 N.m.

SMALL | MEDIUM | LARGE



Gear drives

A gear drive is a mechanical drive that transmits power through the interaction of gear wheels.

The gear wheels operate in pairs to transmit torque and motion from one shaft to another by means of specially shaped projections or teeth.

The teeth on one gear mesh with corresponding teeth on the second gear so that motion is transferred from one to the other without any slippage taking place.

GIVE FEEDBACK

OK

Type your answer in the box.

A gear drive is a mechanical drive that transmits power through the interaction of _____ wheels.

The gear wheels operate in pairs to transmit torque and motion from one shaft to another by means of specially shaped projections or _____ which mesh with each other.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Types of gear drives

There are four main types of gears.

Spur gears are typically used for fuel pumps, automotive gear boxes, steel mills, mechanical clocks and watches.

Worm gears are typically used for elevators, gates, conveyor belts and tuning instruments such as guitars.

Bevel gears are typically used for grain mills, garage doors, egg beaters, hand drills, shaft-driven bicycles and printing presses.

Helical gears are typically used for power transmissions, compressors, elevators, conveyors, cutters, blowers and feeders.

Gear types are determined largely by the relative positions of the input and output shafts.

GIVE FEEDBACK

OK

Type your answer in the box.

The four main types of gears are _____, _____, _____ and _____ gears.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Spur gear

The most common type of gear is the **spur gear**, which has tooth elements that are straight and parallel to its axis.

A spur gear pair can be used to connect parallel shafts only.

Parallel shafts, however, can also be connected by gears of another type.

GIVE FEEDBACK

OK

What shaft connections can be made with spur gears?

Click the correct answer.

- Parallel shafts only
- Perpendicular shafts only
- Parallel and perpendicular shafts
- Skew shafts only
- Skew and perpendicular shafts
- Skew, parallel and perpendicular shafts

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Which type of gear has tooth elements that are straight and parallel to its axis?

Click the correct answer.

- Spur
- Helical
- Bevel
- Worm

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Helical gear

Helical gears have their teeth cut at an angle to the face of the gear.

This arrangement provides greater engagement of the gear teeth and also allows for smoother and quieter operation.

Helical gears have a higher load-carrying capacity than spur gears when connecting parallel shafts.

GIVE FEEDBACK

OK

Type your answer in the box.

Helical gears have their teeth cut at an _____ to the face of the gear.

This arrangement provides greater engagement of the gear teeth and also allows for _____ and _____ operation.

Helical gears have a _____ load-carrying capacity than spur gears when connecting parallel shafts.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Which type of gear has tooth elements that are at an angle to the gear face?

Click the correct answer.

- Helical
- Spur
- Bevel
- Worm

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Helical gears have their teeth cut Select... to the face of the gear.

This arrangement provides greater engagement of the gear teeth and also allows for Select... and Select... operation.

Helical gears have Select... load-carrying capacity than spur gears when connecting parallel shafts.

Submit

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Bevel gear

Bevel gears are gears that are commonly used for transmitting rotary motion and torque around corners.

The connected shafts, whose axes would intersect if extended, are usually at right angles to each other.

GIVE FEEDBACK

OK

Which type of gear is commonly used for transmitting rotary motion and torque around corners?

Click the correct answer.

- Bevel
- Helical
- Spur
- Worm

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Worm gear

Worm gear is a gear of high reduction ratio, connecting shafts whose axes are at right angles but do not intersect.

It consists of a screw-like component carrying a helical thread of special form, the worm, meshing in sliding contact with a concave face gear wheel.

Because of their similarity, the operation and efficiency of a worm and gear depend on the same factors as the operation and efficiency of a screw.

GIVE FEEDBACK

OK

Which type of gear connects shafts whose axes are at right angles but do not intersect?

Click the correct answer.

- Worm
- Helical
- Spur
- Bevel

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Velocity ratio of a gear drive

The velocity ratio of a gear drive is equal to the ratio of the revolutions of the driver wheel (the input) to the revolutions of the driven wheel (the output) in the same time.

In any interval of time, the same number of teeth from both gears come in contact with each other.

Therefore it can be seen that the velocity ratio is the ratio of the number of teeth in the driven wheel to the number of teeth in the driver wheel:

$$VR = \frac{\text{no. of teeth in driven wheel}}{\text{no. of teeth in driver wheel}}$$

GIVE FEEDBACK

OK

Which of the following is the correct equation for the velocity ratio of a gear drive?

Click the correct answer.

$VR = \dfrac{\text{no. of teeth in driven wheel}}{\text{no. of teeth in driver wheel}}$

$VR = \dfrac{\text{no. of teeth in driver wheel}}{\text{no. of teeth in driven wheel}}$

$VR = \text{no. of teeth in driven wheel} + \text{no. of teeth in driver wheel}$

$VR = \text{no. of teeth in driven wheel} \cdot \text{no. of teeth in driver wheel}$

$VR = \text{no. of teeth in driven wheel} - \text{no. of teeth in driver wheel}$

$VR = \text{no. of teeth in driver wheel} - \text{no. of teeth in driven wheel}$

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Type your answer in the box.

The velocity ratio of a gear drive is equal to the ratio of the number of teeth in the _____ wheel to the number of teeth in the _____ wheel.

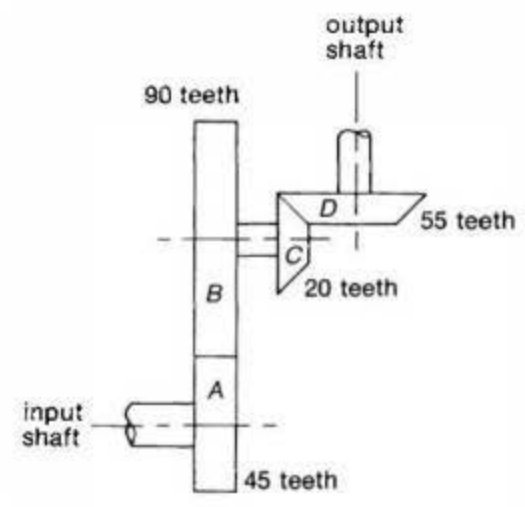
Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Velocity ratio of gear drive

The figure shows a gear drive in a certain machine.

If the input shaft rotates at 660 rpm, determine the output speed and the velocity ratio.



Example	Rotational speed	Velocity ratio	Alternate solution for velocity ratio	Discussion

GIVE FEEDBACK

OK

Velocity ratio of gear drive

Gear A rotates at 660 rpm.

Gear B rotates at $660 \text{ rpm} \times \frac{45}{90} = 330 \text{ rpm}$.

Gear C rotates at 330 rpm.

Gear D rotates at $330 \text{ rpm} \times \frac{20}{55} = 120 \text{ rpm}$.

Therefore the output speed is 120 rpm.

Velocity ratio of gear drive

Comparing the effort speed to the load speed gives:

$$VR = \frac{660}{120}$$
$$= 5.5$$

Therefore the velocity ratio is 5.5 for this gear drive.

Velocity ratio of gear drive

Comparing the teeth for each stage of the gear drive, and since gears B and C move together:

$$VR = \frac{90}{45} \times \frac{55}{20}$$
$$= 5.5$$

Therefore the velocity ratio for this gear drive is 5.5.

Example	Rotational speed	Velocity ratio	Alternate solution for velocity ratio	Discussion

Velocity ratio of gear drive

Velocity ratio is a function of the dimensions and arrangement of the moving parts, e.g. number of teeth in meshing gears.

It is independent of torque and efficiency.

Example	Rotational speed	Velocity ratio	Alternate solution for velocity ratio	Discussion

GIVE FEEDBACK

OK

Type your answer in the box.

A gear drive consists of four gears.

Gear A is the driver gear with 25 teeth and it drives gear B which has 50 teeth.

Gear C has 100 teeth and is constrained to move with gear B. Gear C drives gear D which has 150 teeth.

The velocity ratio of this gear drive is _____.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Type your answer in the box.

A gear drive consists of a driven gear with 52 teeth and a drive gear with 13 teeth.

The velocity ratio of this gear drive is _____.

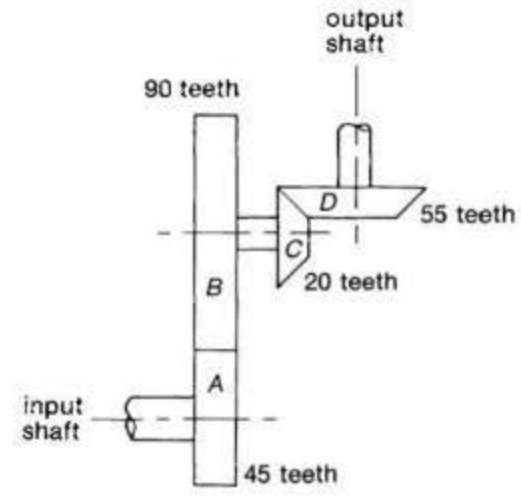
Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Calculate power for a gear drive

The figure shows a gear drive in a certain machine.

If the input shaft rotates at 660 rpm and transmits a torque of 12 N.m, and the efficiency is 80%, determine the input power and the output power.



Example	Rotational speed	Input power	Output power	Discussion

GIVE FEEDBACK

OK

Calculate power for a gear drive

Gear A rotates at 660 rpm.

Gear B rotates at $660\text{ rpm} \times \frac{45}{90} = 330\text{ rpm}$.

Gear C rotates at 330 rpm.

Gear D rotates at $330\text{ rpm} \times \frac{20}{55} = 120\text{ rpm}$.

Therefore the output speed is 120 rpm.

Calculate power for a gear drive

Input power is:

$$P_{\text{in}} = \frac{2\pi NT}{60}$$
$$= \frac{2\pi \times 660 \times 12}{60}$$
$$= 829.4 \text{ W}$$

GIVE FEEDBACK

OK

Calculate power for a gear drive

With an efficiency of 80%, output power is:

$$\begin{aligned} P_{out} &= \eta \times P_{in} \\ &= 0.8 \times 829.4 \\ &= 663.5 \text{ W} \end{aligned}$$

Calculate power for a gear drive

For a real gear set the power output will always be less than the power input because of power losses that occur within the gear drive due to friction.

Example	Rotational speed	Input power	Output power	Discussion

GIVE FEEDBACK

OK

Calculate the input power (correct to the nearest watt).

Clear

Clear line

Undo

Click and type your answer here

CHALLENGE

SUBMIT

SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

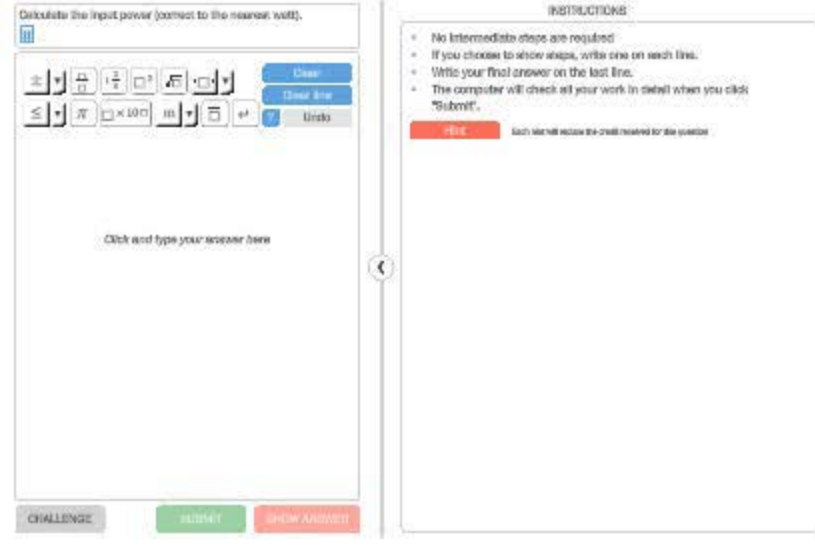
Hint

Each hint will reduce the credit received for this question

A gear drive in a certain machine has a velocity ratio of 6.

When the input shaft rotates at 1000 rpm it transmits a torque of 80 N.m at an efficiency of 85%.

SMALL | MEDIUM | LARGE



A gear drive in a certain machine has a velocity ratio of 6.

When the input shaft rotates at 1000 rpm it transmits a torque of 80 N.m at an efficiency of 85%.

SMALL | MEDIUM | LARGE

Given that the input power is 8,378 W, determine the output power (correct to the nearest watt).

Clear | ? | Undo

Click and type your answer here

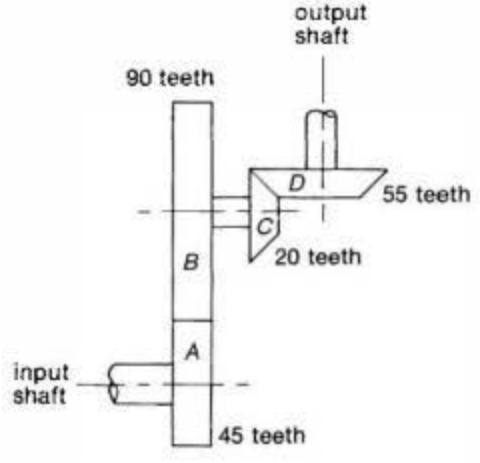
CHALLENGE | SUBMIT | SHOW ANSWER

Calculate efficiency of gear drive

The figure shows a gear drive in a certain machine.

The input shaft rotates at 660 rpm and transmits a torque of 12 N.m, and the output torque is 52.8 N.m.

Determine the efficiency of the gear drive.



Example	Rotational speed	Input power	Output power	Efficiency	Discussion

GIVE FEEDBACK

OK

Calculate efficiency of gear drive

Gear A rotates at 660 rpm.

Gear B rotates at $660\ \text{rpm} \times \frac{45}{90} = 330\ \text{rpm}$.

Gear C rotates at 330 rpm.

Gear D rotates at $330\ \text{rpm} \times \frac{20}{55} = 120\ \text{rpm}$.

Therefore the output speed is 120 rpm.

Calculate efficiency of gear drive

Input power is:

$$P_{\text{in}} = \frac{2\pi NT}{60}$$
$$= \frac{2\pi \times 660 \times 12}{60}$$
$$= 829.4 \text{ W}$$

Calculate efficiency of gear drive

Output power can be calculated from:

$$P_{out} = \frac{2\pi N T_{out}}{60}$$
$$= \frac{2\pi \times 120 \times 52.8}{60}$$
$$= 663.5 \text{ W}$$

Calculate efficiency of gear drive

The efficiency can be calculated from:

$$\begin{aligned}\eta &= \frac{P_{out}}{P_{in}} \\ &= \frac{663.5}{829.4} \\ &= 0.8 \\ &= 80\%\end{aligned}$$

Calculate efficiency of gear drive

Efficiency is the ratio of power output to power input.

Efficiency depends on power losses that occur within the gear drive due to friction.

Example	Rotational speed	Input power	Output power	Efficiency	Discussion

GIVE FEEDBACK

OK

Calculate the power output (correct to the nearest watt).

Clear

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Undo

Click and type your answer here

CHALLENGE

SUBMIT

SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

Hint

Each hint will reduce the credit received for this question

Calculate the power input (correct to the nearest watt).

Clear

Clear line

Undo

Click and type your answer here

CHALLENGE

SUBMIT

SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

Hint

Each hint will reduce the credit received for this question

A gear drive in a certain machine has a velocity ratio of 6.

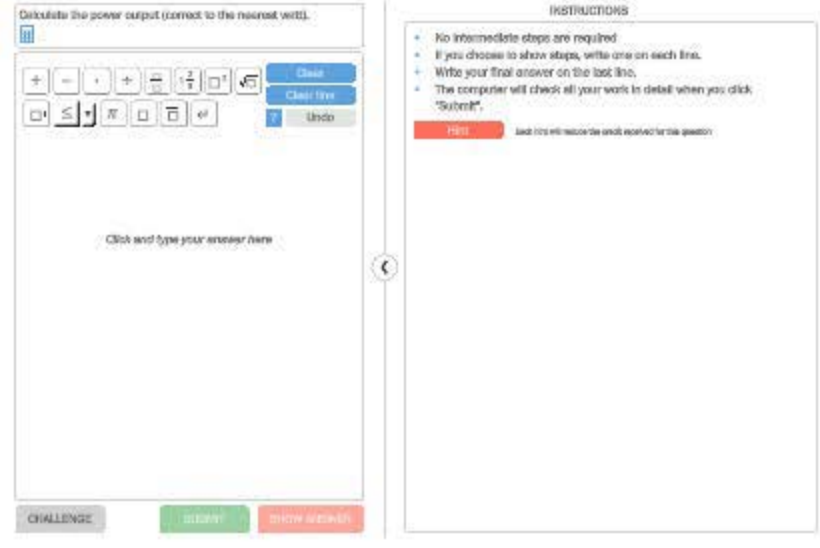
When the input shaft rotates at 1200 rpm it transmits a torque of 90 N.m and the output torque is 430 N.m.

SMALL MEDIUM LARGE

A gear drive in a certain machine has a velocity ratio of 6.

When the input shaft rotates at 1200 rpm it transmits a torque of 90 N.m and the output torque is 430 N.m.

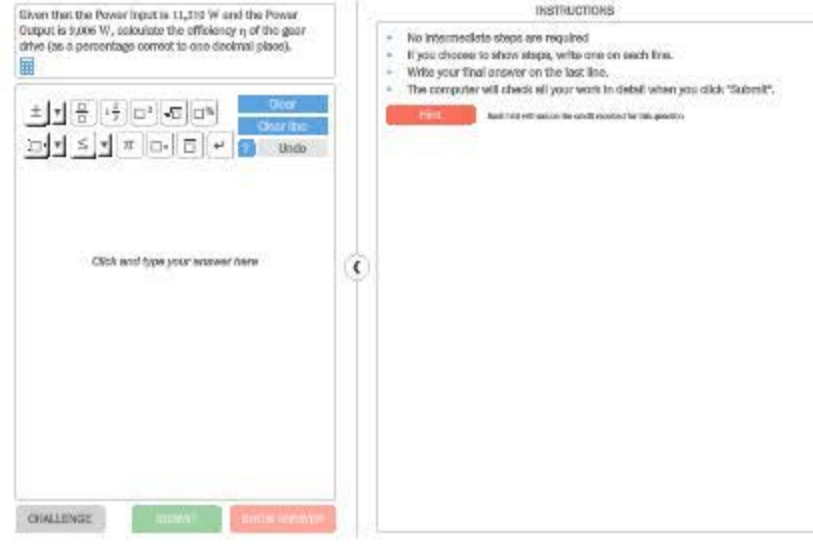
SMALL | MEDIUM | LARGE



A gear drive in a certain machine has a velocity ratio of 6.

When the input shaft rotates at 1200 rpm it transmits a torque of 90 N.m and the output torque is 430 N.m.

SMALL MEDIUM LARGE



Given that the Power Input is 11,310 W and the Power Output is 9,006 W, calculate the efficiency η of the gear drive (as a percentage correct to one decimal place).

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Click and type your answer here

CHALLENGE

SUBMIT

SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

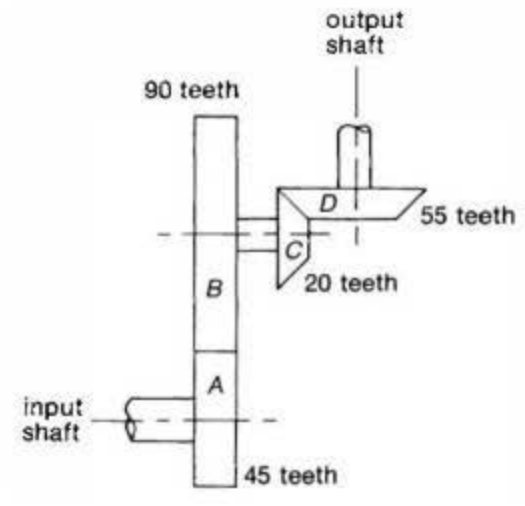
Hint

Each hint will reduce the credit received for this question

Calculate torque of gear drive

The figure shows a gear drive in a certain machine.

If the input shaft rotates at 660 rpm and transmits a torque of 12 N.m, and the efficiency is 80%, determine the output speed, power and torque.



Example	Rotational speed	Input power	Output power	Output torque	Discussion

GIVE FEEDBACK

OK

Calculate torque of gear drive

Gear A rotates at 660 rpm.

Gear B rotates at $660\ \text{rpm} \times \frac{45}{90} = 330\ \text{rpm}$.

Gear C rotates at 330 rpm.

Gear D rotates at $330\ \text{rpm} \times \frac{20}{55} = 120\ \text{rpm}$.

Therefore the output speed is 120 rpm.

Example	Rotational speed	Input power	Output power	Output torque	Discussion

GIVE FEEDBACK

OK

Calculate torque of gear drive

Input power is:

$$P_{\text{in}} = \frac{2\pi NT}{60}$$
$$= \frac{2\pi \times 660 \times 12}{60}$$
$$= 829.4 \text{ W}$$

Calculate torque of gear drive

With an efficiency of 80%, output power is:

$$\begin{aligned} P_{out} &= \eta \times P_{in} \\ &= 0.8 \times 829.4 \\ &= 663.5 \text{ W} \end{aligned}$$

Calculate torque of gear drive

Output torque can be calculated from:

$$P_{out} = \frac{2\pi N T_{out}}{60}$$

$$663.5 = \frac{2\pi \times 120 \times T_{out}}{60}$$

$$T_{out} = \frac{663.5 \times 60}{2\pi \times 120}$$

$$= 52.8\,\mathrm{N.m}$$

Example	Rotational speed	Input power	Output power	Output torque	Discussion

GIVE FEEDBACK

OK

Calculate torque of gear drive

Output torque depends both on velocity ratio and efficiency.

If output torque is not given, it should be calculated from output power and speed.

Example	Rotational speed	Input power	Output power	Output torque	Discussion

GIVE FEEDBACK

OK

A gear drive in a certain machine has a velocity ratio of 6.

When the input shaft rotates at 1200 rpm it transmits a torque of 90 N.m at an efficiency of 78%.

SMALL | MEDIUM | LARGE

Type your answer in the box.

The output speed for this gear drive is _____ rpm.

The input power is _____ watts (correct to the nearest watt).

The output power is _____ watts (correct to the nearest watt).

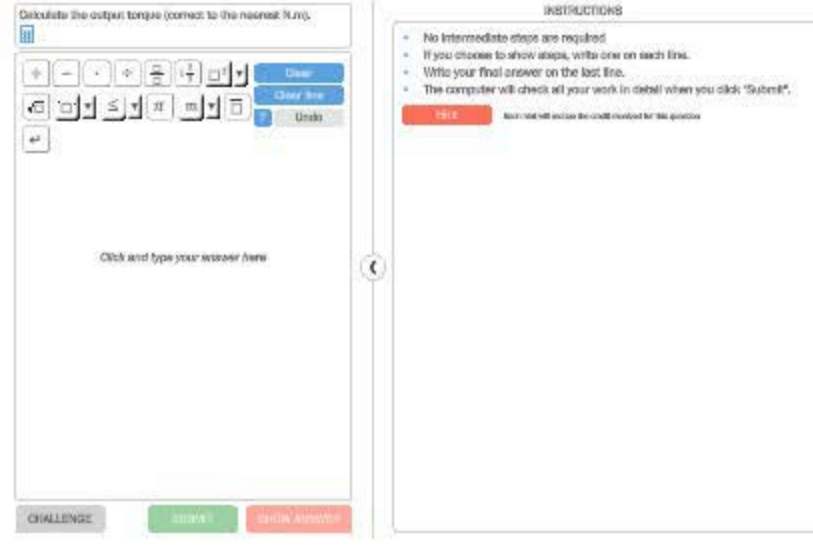
Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

A gear drive in a certain machine has a velocity ratio of 6.

When the input shaft rotates at 1200 rpm it transmits a torque of 90 N.m at an efficiency of 78%.

SMALL MEDIUM LARGE



Calculate the output torque (correct to the nearest N.m).

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Click and type your answer here

CHALLENGE

SUBMIT

SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

Hint

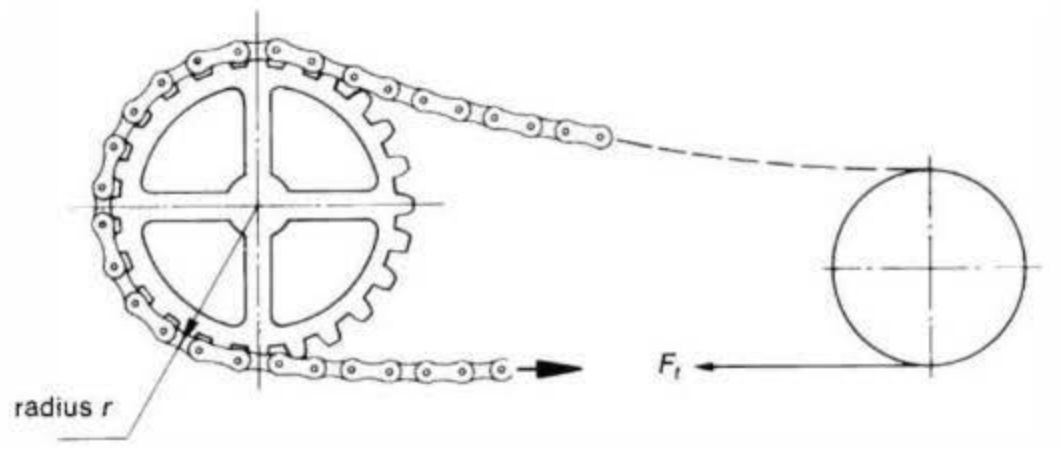
Each hint will reduce the credit received for this question

A chain drive consists of an endless chain of links meshing with the driving and driven sprockets.

A very familiar example is a bicycle chain drive as shown below.

The chain fits into specially shaped teeth cut in the sprockets, which prevent the chain from slipping.

The tension force F_t in the tight side of the chain is responsible for the transmission of power between the two sprockets.



< BACK GIVE FEEDBACK OK

Which of the following statements are true for a chain drive?

Check all that apply.

- [ ] A chain drive consists of an endless chain of links meshing with the driving and driven sprockets
- [ ] The chain of a chain drive fits into specially shaped teeth cut in the sprockets, which prevent the chain from slipping
- [ ] The tension force in the tight side of the chain is responsible for the transmission of power in the chain drive
- [ ] The tension force in the slack side of the chain is responsible for the transmission of power in the chain drive
- [ ] The chain of a chain drive runs in spur gears, which prevent the chain from slipping
- [ ] A chain drive consists of two chains of links meshing only with the driving sprocket

Do you know the answer?

Velocity ratio of chain drive

The velocity ratio for a chain drive may be determined from the number of teeth in the sprockets.

$$VR = \frac{\text{no. of teeth in driven sprocket}}{\text{no. of teeth in driver sprocket}}$$

GIVE FEEDBACK

OK

Type your answer in the box.

For a chain drive, the velocity ratio is equal to the number of teeth in the _____ sprocket divided by the number of teeth in the _____ sprocket.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Which of the following is the correct equation for calculation of the velocity ratio of a chain drive?

Click the correct answer.

$$VR = \frac{\text{no. of teeth in driven sprocket}}{\text{no. of teeth in driver sprocket}}$$

$$VR = \frac{\text{no. of teeth in driver sprocket}}{\text{no. of teeth in driven sprocket}}$$

VR = (no. of teeth in driven sprocket) · (no. of teeth in driver sprocket)

VR = no. of teeth in driven sprocket + no. of teeth in driver sprocket

VR = no. of teeth in driven sprocket − no. of teeth in driver sprocket

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

The efficiency of chain drive

The torque on each sprocket is equal to the force in the chain multiplied by the radius of the sprocket.

In many respects the operation of a chain drive is similar to that of a pair of spur gears, with the exception that the centre distance between two parallel shafts is limited only by the length of the chain.

Efficiency of chain drives is usually high and for our purposes can be assumed to be 100%.

GIVE FEEDBACK

OK

Type your answer in the box.

The _____ on each sprocket is equal to the force in the chain multiplied by the radius of the sprocket.

In many respects the operation of a chain drive is similar to that of a pair of spur gears, with the exception that the centre distance between two parallel shafts is limited only by the _____ of the chain.

Efficiency of chain drives is usually high and for our purposes can be assumed to be _____ %.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Velocity ratio of chain drive

A chain drive transmits power from an 80 mm diameter driver sprocket with 18 teeth to a 200 mm diameter driven sprocket with 45 teeth.

If the speed of the driver is 500 rpm, calculate the velocity ratio and the speed of the driven sprocket.

Velocity ratio of chain drive

The velocity ratio is:

$$VR = \frac{45}{18}$$
$$= 2.5$$

Velocity ratio of chain drive

The velocity ratio is equal to the speed of the driver sprocket divided by the speed of the driven sprocket.

Therefore the velocity of the driven sprocket is:

$$\frac{500}{2.5} = 200 \text{ rpm}$$

Example	Velocity ratio	Driven speed	Discussion

GIVE FEEDBACK

OK

Velocity ratio of chain drive

Note that the velocity ratio is only dependent on the number of teeth on each of the sprockets.

Example | Velocity ratio | Driven speed | Discussion

GIVE FEEDBACK

OK

Type your answer in the box.

A chain drive transmits power from a driver sprocket with 80 teeth to a driven sprocket with 20 teeth.

The velocity ratio is equal to _____.

If the speed of the driver sprocket is 460 rpm, the speed of the driven sprocket is _____ rpm.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Type your answer in the box.

A chain drive transmits power from a driver sprocket with 12 teeth to a driven sprocket with 54 teeth.

The velocity ratio is equal to [ ].

If the speed of the driver sprocket is 945 rpm, the speed of the driven sprocket is [ ] rpm.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Calculate torque of chain drive

A chain drive transmits 20 kW of power from an 80 mm diameter driver sprocket with 18 teeth to a 200 mm diameter driven sprocket with 45 teeth.

If the speed of the driver is 500 rpm, calculate the input and output torque of the chain drive.

Example	Input torque	Driven speed	Output torque

GIVE FEEDBACK

OK

Calculate torque of chain drive

From $P = \frac{2\pi NT}{60}$ input torque is equal to:

$$T_{in} = \frac{60P}{2\pi N}$$
$$= \frac{60 \times 20{,}000}{2\pi \times 500}$$
$$= 382.2\ \mathrm{N.m}$$

Example	Input torque	Driven speed	Output torque

GIVE FEEDBACK

OK

Calculate torque of chain drive

The velocity ratio is:

$$VR = \frac{45}{18}$$
$$= 2.5$$

Therefore the velocity of the driven sprocket is:

$$500 \div 2.5 = 200 \text{ rpm}$$

Example	Input torque	Driven speed	Output torque

GIVE FEEDBACK

OK

If the efficiency is 100%, the output power is undiminished, i.e. it is equal to 20 kW.

Hence output torque is:

$$T_{\text{out}} = \frac{60\,P}{2\pi N}$$
$$= \frac{60 \times 20{,}000}{2\pi \times 200}$$
$$= 955\ \text{N}\,.\,\text{m}$$

Example	Input torque	Driven speed	Output torque

Calculate the input torque (correct to two decimal places).

Clear

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Click and type your answer here

CHALLENGE

SUBMIT

SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

Hint

Each hint will reduce the credit received for this question

A chain drive transmits 1500 W of power from a driver sprocket with 36 teeth to a driven sprocket with 18 teeth.

The speed of the driver sprocket is 300 rpm.

SMALL MEDIUM LARGE

Type your answer in the box.

The velocity ratio of this chain drive is _____.

The speed of the driven sprocket is _____ rpm.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

A chain drive transmits 1500 W of power from a driver sprocket with 36 teeth to a driven sprocket with 18 teeth.

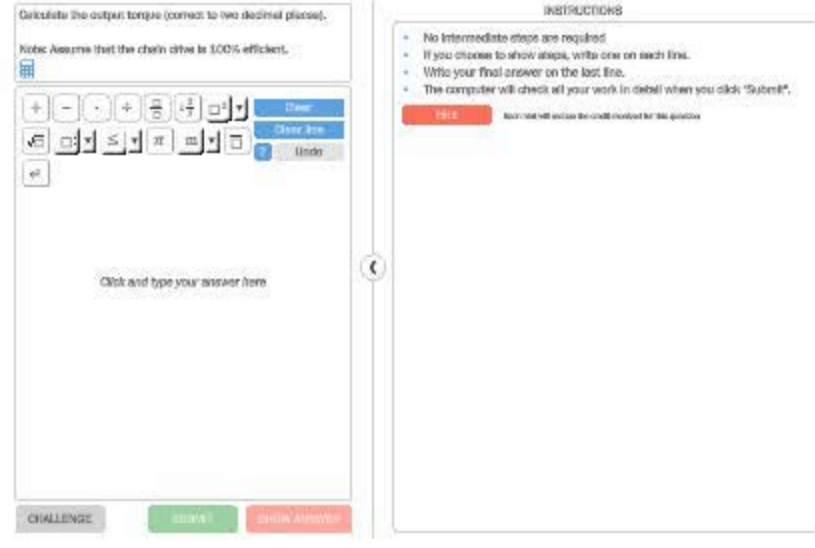
The speed of the driver sprocket is 300 rpm.

SMALL | MEDIUM | LARGE

A chain drive transmits 1500 W of power from a driver sprocket with 36 teeth to a driven sprocket with 18 teeth.

The speed of the driver sprocket is 300 rpm.

SMALL MEDIUM LARGE



Calculate the output torque (correct to two decimal places).

Note: Assume that the chain drive is 100% efficient.

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Click and type your answer here

CHALLENGE

SUBMIT

SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required
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Hint

Each hint will reduce the credit received for this question

Calculate power of chain drive

A chain drive has an 80 mm diameter driver sprocket with 18 teeth to a 200 mm diameter driven sprocket with 45 teeth.

If the torque applied to the driver is 382 N.m and the speed of the driver is 500 rpm, calculate the input and output power.

Example	Input power	Output power	Discussion

GIVE FEEDBACK

OK

Calculate power of chain drive

The input power is equal to:

$$P_{\text{in}} = \frac{2\pi NT}{60}$$
$$= \frac{2\pi \times 500 \times 382}{60}$$
$$= 20{,}001 \text{ W}$$

Example	Input power	Output power	Discussion

GIVE FEEDBACK

OK

Calculate power of chain drive

The output power is equal to:

$$\begin{aligned} P_{\text{out}} &= \eta \times P_{\text{in}} \\ &= 100\% \times 20{,}001 \\ &= 20{,}001 \text{ W} \end{aligned}$$

Calculate power of chain drive

Notice that, if the input power and efficiency are known, it is not necessary to determine the velocity ratio in order to calculate the output power.

Example	Input power	Output power	Discussion

GIVE FEEDBACK

OK

Knowing the input power is 3665 W and assuming the efficiency is 100%, calculate the output power.

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$(\square)$ ▼ ≤ ▼ π $\square$ $\square_n$ $\overline{\square}$? Undo

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CHALLENGE SUBMIT SHOW ANSWER

Calculate the input power (correct to the nearest watt).

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Click and type your answer here

CHALLENGE

SUBMIT

SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
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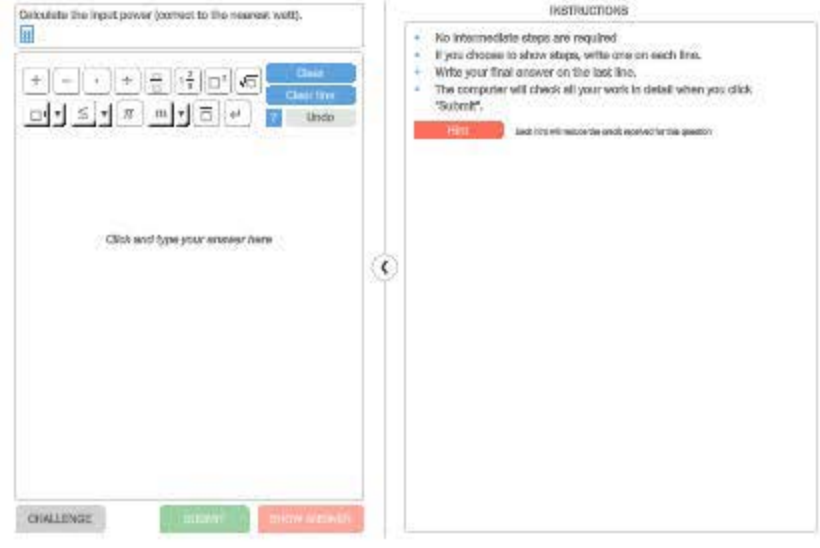
Hint

Each hint will reduce the credit received for this question

A chain drive has a driver sprocket with 36 teeth and a driven sprocket with 18 teeth.

The torque applied to the driver is 100 N.m and the speed of the driver is 350 rpm.

SMALL MEDIUM LARGE



A chain drive has a driver sprocket with 36 teeth and a driven sprocket with 18 teeth.

The torque applied to the driver is 100 N.m and the speed of the driver is 350 rpm.

SMALL | MEDIUM | LARGE

Knowing the input power is 3665 W and assuming the efficiency is 100%, calculate the output power.

Clear | ? | Undo

Click and type your answer here

CHALLENGE | SUBMIT | SHOW ANSWER

Tension in bicycle chain

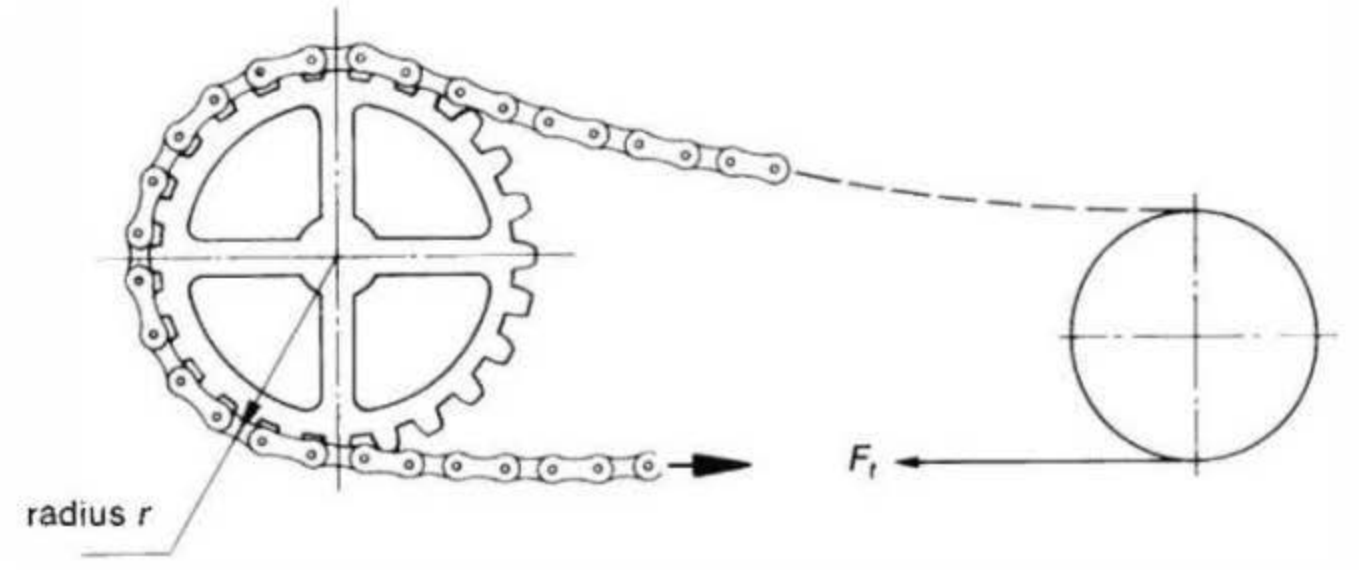


Figure	Tension in the chain

GIVE FEEDBACK

OK

Tension in bicycle chain

The force of tension in the chain is found from:

$$T = F_t \times r$$

Therefore:

$$F_t = \frac{T}{r}$$

where:

T is the torque
F_t is the force of tension in the chain
r is the corresponding radius

Figure	Tension in the chain

GIVE FEEDBACK

OK

Which of the following is the correct equation for calculation of the tension in the chain of a chain drive?

Click the correct answer.

$F_t = \frac{T}{r}$

$F_t = T \cdot r$

$F_t = T + r$

$F_t = \sqrt{T^2 + r^2}$

$F_t = T - r$

$F_t = r - T$

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Match each of the symbols from the equation $F_t = \frac{T}{r}$ with the correct description.

Drag statements on the right to match the left.

F_t	Tension force in the chain
T	Torque applied to the sprocket
r	Radius of the sprocket

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Calculate tension in chain of chain drive

A chain drive transmits 20 kW of power from an 80 mm diameter driver sprocket with 18 teeth to a 200 mm diameter driven sprocket with 45 teeth.

If the speed of the driver is 500 rpm, calculate the tension force in the chain.

Example	Input torque	Chain tension

GIVE FEEDBACK

OK

Calculate tension in chain of chain drive

From $P = \frac{2\pi NT}{60}$ input torque is equal to:

$$T_{in} = \frac{60P}{2\pi N}$$
$$= \frac{60 \times 20{,}000}{2\pi \times 500}$$
$$= 382.2 \text{ N.m}$$

Calculate tension in chain of chain drive

The force of tension in the chain is found from $T = F_t \times r$, where T is torque and r is the corresponding radius:

$$\begin{aligned} F_t &= \frac{T}{r} \\ &= \frac{382}{0.04} \\ &= 9{,}550 \text{ N} \\ &= 9.55 \text{ kN} \end{aligned}$$

Example	Input torque	Chain tension

GIVE FEEDBACK

OK

A chain drive transmits 2500 W of power from a 100 mm diameter driver sprocket with 28 teeth to a 200 mm diameter driven sprocket with 63 teeth.

The speed of the driver is 820 rpm.

SMALL | MEDIUM | LARGE

A chain drive transmits 2500 W of power from a 100 mm diameter driver sprocket with 28 teeth to a 200 mm diameter driven sprocket with 63 teeth.

The speed of the driver is 820 rpm.

SMALL | MEDIUM | LARGE

Calculate the tension in the chain (correct to one decimal place).

Clear | ? | Undo

Click and type your answer here

CHALLENGE | SUBMIT | SHOW ANSWER

Calculate the input torque (correct to two decimal places).

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Click and type your answer here

CHALLENGE

SUBMIT

SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

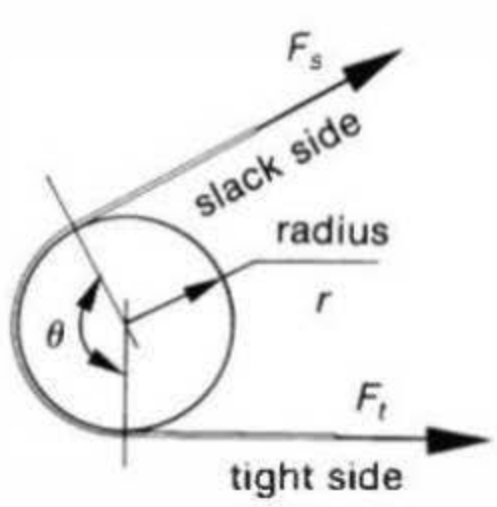
Hint

Each hint will reduce the credit received for this question

A flat belt drive transmits power through flat belts and pulleys.

Power transmission by belts is possible only with sufficient friction between the belt and its pulleys.

In order to provide the necessary grip on the pulley, both sides of the belt must be in tension, i.e. there must be a tension force in both sides of the belt, as illustrated in the figure below.



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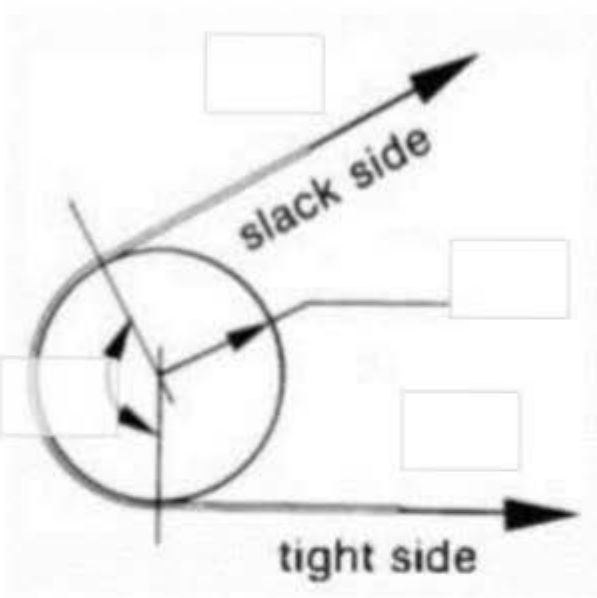
Correctly label the diagram of the flat belt drive.



r θ F_s F_t

Submit

Do you know the answer?

Which of the following are true statements about flat belt drives?

Check all that apply.

- [ ] A flat belt drive transmits power through flat belts and pulleys
- [ ] Power transmission by belts is possible only with sufficient friction between the belt and its pulleys
- [ ] A flat belt drive transmits power through flat belts and sprockets
- [ ] In order to provide the necessary grip on the pulley, both sides of the flat belt must be in tension
- [ ] Power transmission by belts is possible due to contact between the belt and toothed sprockets

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Belt tension in flat belt drive

As a result of applied torque and the friction between the belt and the pulley, there is a difference between the tight-side tension, F_t and the slack-side tension, F_s.

It can be shown that friction limits the ratio between these two belt tensions according to the equation:

$$\frac{F_t}{F_s} = e^{\mu\theta}$$

where:

e is a constant and is equal to 2.71828 ...

μ is the coefficient of friction between the belt and the pulley

θ is the angle of contact in radians

e is a mathematical constant and is usually available as a function key on most scientific calculators.

GIVE FEEDBACK

OK

Which of the following states the correct relationship between the tensions in the belt of a flat belt drive?

Click the correct answer.

$\frac{F_t}{F_s} = e^{\mu\theta}$

$\frac{F_s}{F_t} = e^{\mu\theta}$

$\frac{F_t}{F_s} = \mu^{e\,\theta}$

$\frac{F_s}{F_t} = \mu^{e\,\theta}$

$\frac{F_t}{F_s} = \theta^{e\,\mu}$

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Match each of the symbols from the equation $\frac{F_t}{F_s} = e^{\mu\theta}$ with the correct description.

Drag statements on the right to match the left.

F_t	The tension in the taut side of the belt
F_s	The tension in the slack side of the belt
e	A constant approximately equal to 2.71828
μ	The coefficient of friction between the belt and the pulley
θ	The angle of contact between the belt and the pulley

Do you know the answer?

Torque of flat belt drive about centreline of pulley

The torque for a flat belt drive pulley is equal to the algebraic sum of the moments of the two forces about the centreline of the pulley.

$$T = F_t r - F_s r = r(F_t - F_s)$$

where:

T is the torque applied to the pulley

F_t is the tension in the taut side of the belt

F_s is the tension in the slack side of the belt

r is the radius of the pulley

GIVE FEEDBACK

OK

Which of the following is the correct equation for the torque applied to a pulley in a flat belt drive?

Click the correct answer.

$T = r(F_t - F_s)$

$T = r(F_s - F_t)$

$T = \frac{r}{(F_t - F_s)}$

$T = \frac{(F_t - F_s)}{r}$

$T = r(F_t + F_s)$

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Match each of the symbols from the equation $T = r\,(F_t - F_s)$ with the correct description.

Drag statements on the right to match the left.

T	Torque applied to pulley
F_t	Tension in the taut side of the belt
F_s	Tension in the slack side of the belt
r	Radius of the pulley

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Calculate tension in belt for flat belt drive

A flat belt has a maximum tension of 500 N, the coefficient of friction is 0.25, the angle of contact is 150° and the diameter of the pulley is 300 mm.

Determine the tension in the slack side of the belt.

Example	Given data	Tension

GIVE FEEDBACK

OK

Calculate tension in belt for flat belt drive

Given:

$$\mu = 0.25$$
$$\theta = 150^{o}$$
$$= 150 \times \frac{\pi}{180}$$
$$= 2.618 \text{ rad}$$
$$F_t = 500 \text{ N}$$

Example | Given data | Tension

GIVE FEEDBACK

OK

Calculate tension in belt for flat belt drive

We can find the slack-side tension from:

$$\frac{F_t}{F_s} = e^{\mu\theta}$$

$$\frac{500}{F_s} = e^{0.25 \times 2.618}$$

$$\therefore F_s = 260\ \text{N}$$

Example	Given data	Tension

GIVE FEEDBACK

OK

Type your answer in the box.

A flat belt has a slack side tension of 90 N, the coefficient of friction is 0.28, the angle of contact is 135° and the diameter of the pulley is 275 mm.

The angle of contact is _____ radians (correct to three decimal places).

The tension in the taut side of the belt is _____ N (correct to one decimal place).

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Type your answer in the box.

A flat belt has a maximum tension of 280 N, the coefficient of friction is 0.3, the angle of contact is 120° and the diameter of the pulley is 300 mm.

The angle of contact is _____ radians (correct to three decimal places).

The tension in the slack side of the belt is _____ N (correct to one decimal place).

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Calculate torque transmitted through flat belt drive

Determine the maximum torque that can be transmitted by a flat belt drive if the maximum tension is 500 N, the coefficient of friction is 0.25, the angle of contact is 150° and the diameter of the pulley is 300 mm.

Example	Given data	Tension	Torque

GIVE FEEDBACK

OK

Calculate torque transmitted through flat belt drive

Given:

$$\mu = 0.25$$
$$\theta = 150^{o}$$
$$= 150 \times \frac{\pi}{180}$$
$$= 2.618 \text{ rad}$$
$$F_t = 500 \text{ N}$$

GIVE FEEDBACK

OK

Calculate torque transmitted through flat belt drive

We can find the slack-side tension from:

$$\frac{F_t}{F_s} = e^{\mu\theta}$$

$$\frac{500}{F_s} = e^{0.25 \times 2.618}$$

$$\therefore F_s = 260\ \text{N}$$

GIVE FEEDBACK

OK

Calculate torque transmitted through flat belt drive

Therefore torque is:

$$\begin{aligned} T &= r\,(F_t - F_s) \\ &= 0.15\,(500 - 260) \\ &= 36\ \text{N.m} \end{aligned}$$

Example	Given data	Tension	Torque

GIVE FEEDBACK

OK

A flat belt drive has a maximum belt tension of 300 N, the coefficient of friction is 0.29, the angle of contact is 135° and the diameter of the pulley is 280 mm.

SMALL MEDIUM LARGE

Type your answer in the box.

The angle of contact is _____ radians (correct to three decimal places).

The tension in the slack side of the belt is _____ N (correct to one decimal place).

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

A flat belt drive has a maximum belt tension of 300 N, the coefficient of friction is 0.29, the angle of contact is 135° and the diameter of the pulley is 280 mm.

SMALL MEDIUM LARGE

Calculate the torque transmitted by the pulley (correct to two decimal places).

Clear

Undo

Click and type your answer here

CHALLENGE SUBMIT SHOW ANSWER

Calculate power transmitted through flat belt drive

Determine the power transmitted by a flat belt drive operating at 650 rpm if the maximum tension is 500 N, the coefficient of friction is 0.25, the angle of contact is 150° and the diameter of the pulley is 300 mm.

Example	Given data	Tension	Torque	Power

GIVE FEEDBACK

OK

Calculate power transmitted through flat belt drive

Given:

$$\mu = 0.25$$
$$\theta = 150^{o}$$
$$= 150 \times \frac{\pi}{180}$$
$$= 2.618 \text{ rad}$$
$$F_t = 500 \text{ N}$$
$$N = 650 \text{ rpm}$$

GIVE FEEDBACK

OK

Calculate power transmitted through flat belt drive

We can find the slack-side tension from:

$$\frac{F_t}{F_s} = e^{\mu\theta}$$

$$\frac{500}{F_s} = e^{0.25 \times 2.618}$$

$$\therefore F_s = 260\ \text{N}$$

Calculate power transmitted through flat belt drive

Therefore torque is:

$$\begin{aligned} T &= r\,(F_t - F_s) \\ &= 0.15\,(500 - 260) \\ &= 36\ \mathrm{N.m} \end{aligned}$$

GIVE FEEDBACK

OK

Calculate power transmitted through flat belt drive

The power can be calculated from:

$$P = \frac{2\pi NT}{60}$$
$$= \frac{(2\pi)(650)(36)}{60}$$
$$= 2{,}450 \text{ W}$$

Example	Given data	Tension	Torque	Power

GIVE FEEDBACK

OK

Knowing that the torque applied to the pulley is 11.856 Nm, calculate the power transmitted by the flat belt drive (correct to one decimal place).

Clear

Clear line

Undo

Click and type your answer here

CHALLENGE

SUBMIT

SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

Hint

Each hint will reduce the credit received for this question

Calculate the torque applied to the pulley (correct to three decimal places).

Clear

Clear line

Undo

Click and type your answer here

CHALLENGE

SUBMIT

SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

Hint

Each hint will reduce the credit received for this question

A flat belt drive operating at 300 rpm has a maximum belt tension of 115 N, the coefficient of friction is 0.32, the angle of contact is 140° and the diameter of the pulley is 380 mm.

SMALL MEDIUM LARGE

Type your answer in the box.

The angle of contact is _____ radians (correct to three decimal places).

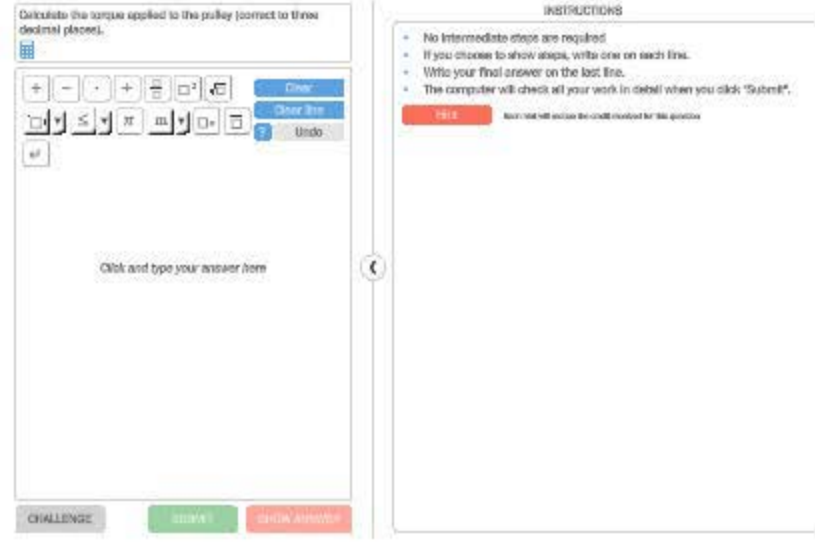
The tension in the slack side of the belt is _____ N (correct to one decimal place).

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

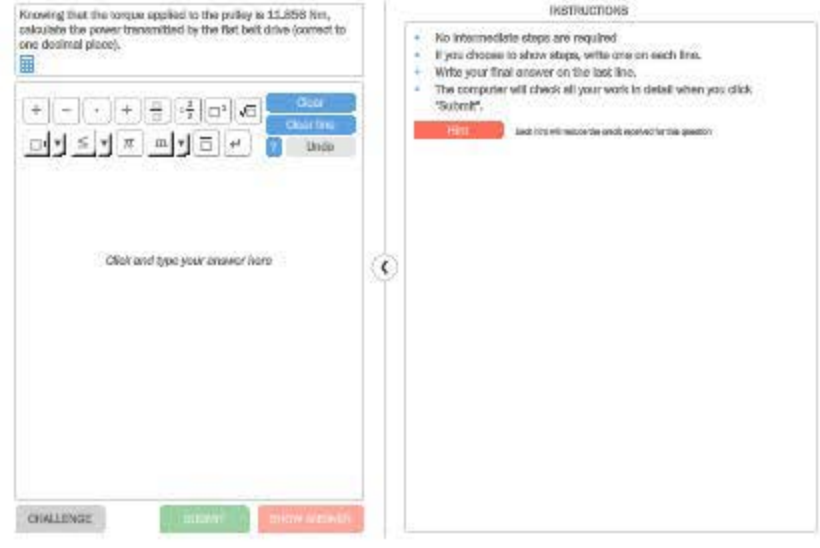
A flat belt drive operating at 300 rpm has a maximum belt tension of 115 N, the coefficient of friction is 0.32, the angle of contact is 140° and the diameter of the pulley is 380 mm.

SMALL MEDIUM LARGE



A flat belt drive operating at 300 rpm has a maximum belt tension of 115 N, the coefficient of friction is 0.32, the angle of contact is 140° and the diameter of the pulley is 380 mm.

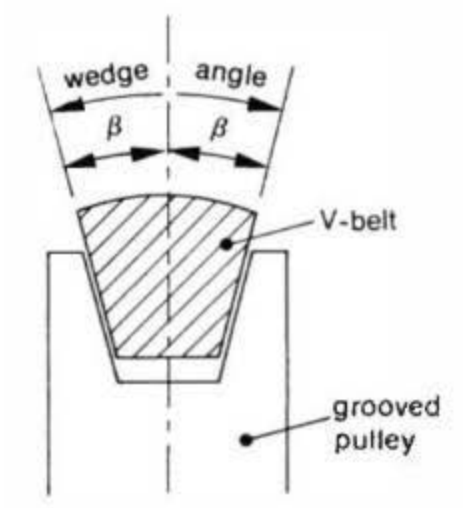
SMALL | MEDIUM | LARGE



The V-belt drive consists of a belt with a vee-shaped cross-section that operates specially shaped pulleys.

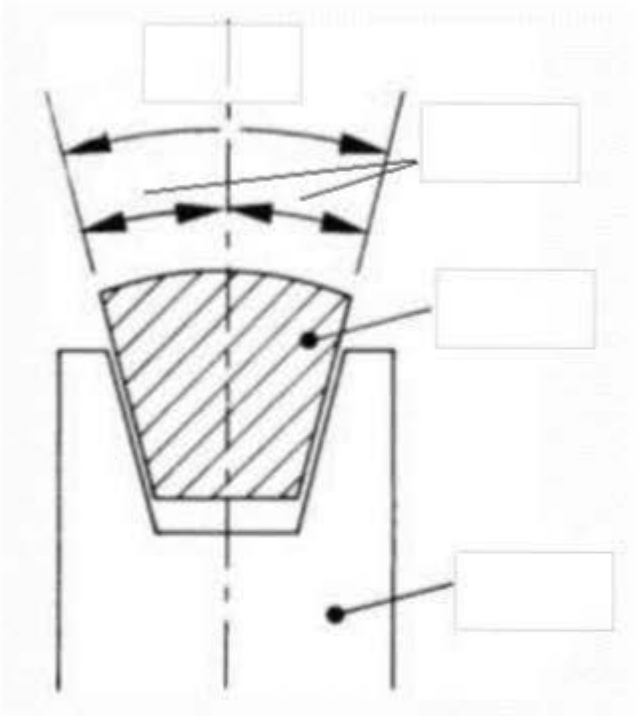
The V-belt drive benefits from the wedging effect produced by the rubber belt in the specially shaped groove of the pulley (see the figure below).

The wedging action of the belt tension increases the normal force on the belt and hence increases friction which provides the grip.



< BACK GIVE FEEDBACK OK

Correctly label the diagram of the V-belt.



β | grooved pulley | wedge angle | V-belt

Submit

Type your answer in the box.

The V-belt drive consists of a belt with a [ ]-shaped cross-section that operates specially shaped pulleys.

The V-belt drive benefits from the [ ] effect produced by the rubber belt in the specially shaped groove of the pulley.

The wedging action of the belt tension [ ] the normal force on the belt and hence increases friction which provides the grip.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Belt tensions in V-belt drive

The flat belt drive equation can be modified to include the added friction provided by the V-belt by the inclusion of the sine of one-half of the wedge angle.

$$\frac{F_t}{F_s} = e^{\mu\theta/\sin\beta}$$

where:

F_t is the tension in the taut side of the V-belt

F_s is the tension in the slack side of the V-belt

e is a constant that is approximately equal to 2.71828

μ is the coefficient of friction between the V-belt and the pulley

θ is the contact angle between the V-belt and the pulley

β is equal to half of the wedge angle

Notes:

1. This equation is sometines shown as $\frac{F_t}{F_s} = e^{(\mu\theta)(\operatorname{cosec}\beta)}$.

2. The smaller of the two arcs of contact is used in this equation because that is where the belt will slip first and it therefore determines the power transmission.

GIVE FEEDBACK

OK

Which of the following states the correct relationship for the tensions in a V-belt drive?

Click the correct answer.

$$\frac{F_t}{F_s} = e^{\left(\frac{\mu\theta}{\sin\beta}\right)}$$

$$\frac{F_t}{F_s} = e^{\left(\frac{\beta\theta}{\sin\mu}\right)}$$

$$\frac{F_s}{F_t} = e^{\left(\frac{\mu\theta}{\sin\beta}\right)}$$

$$\frac{F_s}{F_t} = e^{\left(\frac{\beta\theta}{\sin\mu}\right)}$$

$$\frac{F_t}{F_s} = e^{\left(\frac{\mu\beta}{\sin\theta}\right)}$$

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Match each of the symbols from the equation $\frac{F_t}{F_s} = e^{\left(\frac{\mu\theta}{\sin\beta}\right)}$ with the correct description.

Drag statements on the right to match the left.

F_t	Tension in the taut side of the belt
F_s	Tension in the slack side of the belt
e	A constant approximately equal to 2.71828
μ	Coefficient of friction between the belt and the pulley
θ	Angle of contact between the belt and the pulley
β	One-half of the wedge angle

Torque of V-belt drive

The torque for a V-belt drive pulley is equal to the algebraic sum of the moments of the two forces about the centreline of the pulley.

$$T = F_t r - F_s r = r(F_t - F_s)$$

where:

T is the torque applied to the pulley

F_t is the tension in the taut side of the belt

F_s is the tension in the slack side of the belt

r is the radius of the pulley

GIVE FEEDBACK

OK

Match each of the symbols from the equation $T = r\,(F_t - F_s)$ with the correct description.

Drag statements on the right to match the left.

T	Torque applied to the pulley
F_t	Tension in the taut side of the belt
F_s	Tension in the slack side of the belt
r	Radius of the pulley

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Calculate tension in belt given wedge angle

A V-belt drive with a wedge angle of 40° has a maximum tension of 500 N, the coefficient of friction is 0.25, the angle of contact is 150° and the diameter of the pulley is 300 mm.

Determine the tension in the slack side of the belt.

Example	Given data	Tension

GIVE FEEDBACK

OK

Calculate tension in belt given wedge angle

Given:

$$\mu = 0.25$$
$$\theta = 150^{o}$$
$$= 150 \times \frac{\pi}{180}$$
$$= 2.618 \text{ rad}$$
$$F_t = 500 \text{ N}$$

The wedge angle is 40° therefore:

$$\beta = 20°$$

Example | Given data | Tension

Calculate tension in belt given wedge angle

We can find the slack-side tension from:

$$\frac{F_t}{F_s} = e^{\left(\frac{\mu\theta}{\sin\beta}\right)}$$

$$\frac{500}{F_s} = e^{\left(\frac{0.25 \times 2.618}{\sin 20^\circ}\right)}$$

$$\therefore F_s = 73.8\ \text{N}$$

Example	Given data	Tension

GIVE FEEDBACK

OK

Type your answer in the box.

A V-belt with a wedge angle of 46° has a maximum tension of 280 N, the coefficient of friction is 0.3, the angle of contact is 120° and the diameter of the pulley is 300 mm.

The angle of contact is _____ radians (correct to three decimal places).

The tension in the slack side of the belt is _____ N (correct to one decimal place).

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Type your answer in the box.

A V-belt with a wedge angle of 42° has a slack-side tension of 90 N, the coefficient of friction is 0.28, the angle of contact is 135° and the diameter of the pulley is 275 mm.

The angle of contact is _____ radians (correct to three decimal places).

The tension in the taut side of the belt is _____ N (correct to one decimal place).

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Calculate torque transmitted through V-belt drive

A V-belt drive with a wedge angle of 40° has a maximum tension of 500 N, the coefficient of friction is 0.25, the angle of contact is 150° and the diameter of the pulley is 300 mm.

Calculate the maximum torque.

Example	Given data	Tension	Torque

GIVE FEEDBACK

OK

Calculate torque transmitted through V-belt drive

Given:

$$\mu = 0.25$$
$$\theta = 150^{o}$$
$$= 150 \times \frac{\pi}{180}$$
$$= 2.618 \text{ rad}$$
$$F_t = 500 \text{ N}$$

The wedge angle is 40° therefore:

$$\beta = 20°$$

GIVE FEEDBACK

OK

Calculate torque transmitted through V-belt drive

We can find the slack-side tension from:

$$\frac{F_t}{F_s} = e^{\left(\frac{\mu\theta}{\sin\beta}\right)}$$

$$\frac{500}{F_s} = e^{\left(\frac{0.25 \times 2.618}{\sin 20^\circ}\right)}$$

$$\therefore F_s = 73.8\ \text{N}$$

Calculate torque transmitted through V-belt drive

Torque is:

$$T = 0.15(500 - 73.8)$$
$$= 63.9\ \mathrm{N.m}$$

Example	Given data	Tension	Torque

GIVE FEEDBACK

OK

A V-belt drive with a wedge angle of 48° has a maximum belt tension of 300 N, the coefficient of friction is 0.29, the angle of contact is 135° and the diameter of the pulley is 280 mm.

SMALL MEDIUM LARGE

Type your answer in the box.

The angle of contact is _____ radians (correct to three decimal places).

The tension in the slack side of the belt is _____ N (correct to one decimal place).

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

A V-belt drive with a wedge angle of 48° has a maximum belt tension of 300 N, the coefficient of friction is 0.29, the angle of contact is 135° and the diameter of the pulley is 280 mm.

SMALL | MEDIUM | LARGE

Calculate the torque transmitted by the pulley (correct to two decimal places).

Clear

Undo

Click and type your answer here

CHALLENGE | SUBMIT | SHOW ANSWER

Calculate power transmitted through V-belt drive

Determine the power transmitted by a V-belt drive with a wedge angle of 40° operating at 650 rpm if the maximum tension is 500 N, the coefficient of friction is 0.25, the angle of contact is 150° and the diameter of the pulley is 300 mm.

Example	Given data	Tension	Torque	Power

GIVE FEEDBACK

OK

Calculate power transmitted through V-belt drive

Given:

$$\mu = 0.25$$
$$\theta = 150^{o}$$
$$= 150 \times \frac{\pi}{180}$$
$$= 2.168 \text{ rad}$$
$$F_t = 500 \text{ N}$$

The wedge angle is 40° therefore:

$$\beta = 20°$$

Calculate power transmitted through V-belt drive

We can find the slack-side tension from:

$$\frac{F_t}{F_s} = e^{\left(\frac{\mu\theta}{\sin\beta}\right)}$$

$$\frac{500}{F_s} = e^{\left(\frac{0.25 \times 2.618}{\sin 20°}\right)}$$

$$\therefore F_s = 73.8\,\text{N}$$

Calculate power transmitted through V-belt drive

Torque is:

$$T = 0.15(500 - 73.8)$$
$$= 63.9\ \text{N.m}$$

GIVE FEEDBACK

OK

Calculate power transmitted through V-belt drive

The power can be calculated from:

$$P = \frac{2\pi NT}{60}$$
$$= \frac{(2\pi)(650)(63.9)}{60}$$
$$= 4{,}350 \text{ W}$$

Example	Given data	Tension	Torque	Power

GIVE FEEDBACK

OK

A V-belt drive with a wedge angle of 44° operating at 300 rpm has a maximum belt tension of 115 N, the coefficient of friction is 0.32, the angle of contact is 140° and the diameter of the pulley is 380 mm.

SMALL MEDIUM LARGE

Type your answer in the box.

The angle of contact is _____ radians (correct to three decimal places).

The tension in the slack side of the belt is _____ N (correct to two decimal places).

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

A V-belt drive with a wedge angle of 44° operating at 300 rpm has a maximum belt tension of 115 N, the coefficient of friction is 0.32, the angle of contact is 140° and the diameter of the pulley is 380 mm.

SMALL | MEDIUM | LARGE

Calculate the torque applied to the pulley (correct to two decimal places).

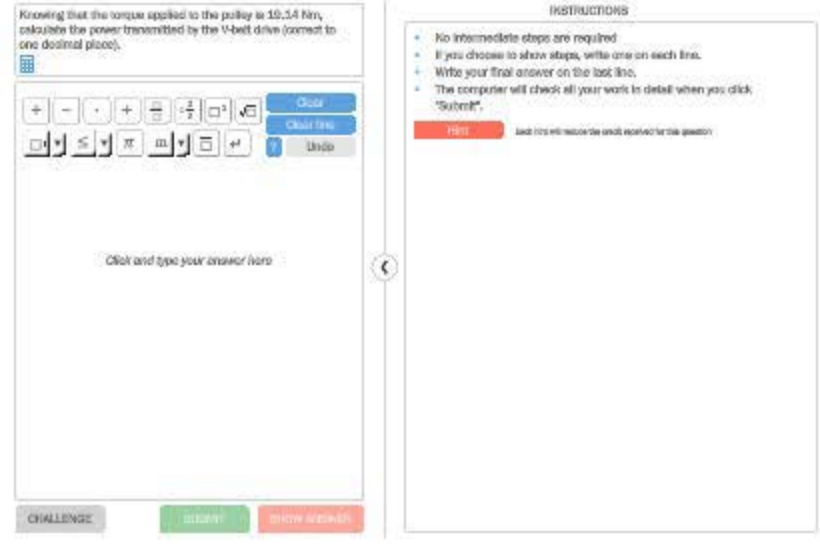
Clear | ? | Undo

Click and type your answer here

CHALLENGE | SUBMIT | SHOW ANSWER

A V-belt drive with a wedge angle of 44° operating at 300 rpm has a maximum belt tension of 115 N, the coefficient of friction is 0.32, the angle of contact is 140° and the diameter of the pulley is 380 mm.

SMALL MEDIUM LARGE



Knowing that the torque applied to the pulley is 19.14 Nm, calculate the power transmitted by the V-belt drive (correct to one decimal place).

Clear

Clear line

Undo

Click and type your answer here

CHALLENGE

SUBMIT

SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

Hint

Each hint will reduce the credit received for this question

Advantages of V-belt drive over flat belt drive

When a V-belt drive is compared with the equivalent flat belt drive, the torque is much larger.

The power transmitted at a given speed would also be much greater.

The efficiency of a V-belt drive ranges from 90 to 98 per cent, with a generally accepted average of 95 per cent.

For the sake of simplicity in presentation, we have assumed 100 per cent efficiency for all calculations involving flat belt and V-belt drives in this resource.

Likewise we have ignored the effect of centrifugal force, which at high velocities tends to lift the belt off the pulley, thus reducing the frictional grip.

Type your answer in the box.

A V-belt drive compared with the equivalent flat belt drive has much _____ torque and power transmitted.

The efficiency of a V-belt drive has a generally accepted average of _____ %.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

A V-belt drive compared with the equivalent flat belt drive has a much Select... torque and power transmitted.

The efficiency of a V-belt drive has a generally accepted average of Select... %.

Submit

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA