GIVE FEEDBACK

CONTINUE >

Dynamic systems involve the movement of more than one component and the interaction of these components. An example of a dynamic system is a block and tackle lifting device.

The **force-acceleration method** is an approach that can be used to analyse systems of dynamically interacting bodies.

The method uses the relationship between applied effort and acceleration to obtain mathematical relationships between elements of a dynamic system.

< BACK GIVE FEEDBACK OK

The two formulas of Newton's second law for linear and rotational motion

Newton's second law can be expressed mathematically for linear motion and for rotational motion.

$$F = m a$$

where:

F is the applied force

m is the mass of the body

a is the acceleration of the body

$$T = I \alpha$$

where:

T is the applied torque

I is the mass moment of inertia of the body

α is the angular acceleration of the body

GIVE FEEDBACK

OK

Type your answer in the box.

In the equation $F = m\,a$ the symbol F represents the ______, the symbol m represents the ______ of the body and the symbol a represents the ______.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Match the symbol from the equation $F = m\, a$ with the correct description.

Drag statements on the right to match the left.

F	Applied force
m	Mass of the body
a	Acceleration of the body

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Type your answer in the box.

In the equation $T = I\alpha$ the symbol T represents the [ ], the symbol I represents the mass moment of [ ] of the body and the symbol α represents the [ ] acceleration.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Match the symbol from the equation $T = I\alpha$ with the correct description.

Drag statements on the right to match the left.

T	Applied torque
I	Mass moment of inertia of the body
α	Angular acceleration of the body

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

A system of bodies in motion

Mechanical devices and simple machines usually consist of two or more components constrained to move together, a situation that can be described as 'a system of bodies in motion'.

GIVE FEEDBACK

OK

Which of the following are examples of a system of bodies in motion?

Check all that apply.

- [ ] Pulleys connected by a rope
- [ ] A car towing a caravan
- [ ] A winch used to lift a load
- [ ] A ball rolling down a hill
- [ ] A car travelling up a hill
- [ ] A flywheel rotating at 500 rpm

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

What is a system of bodies in motion?

Click the correct answer.

- Two or more components constrained to move together
- A body in motion
- A body that rotates and changes position
- Two or more components that move independently from each other
- Two or more components that move at the same velocity

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Type your answer in the box.

Mechanical devices and simple machines usually consist of two or more components constrained to move together, a situation that can be described as 'a ________ of ________ in motion'.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

The system of bodies is idealised to assist in analysis. If necessary, complications such as friction and weight of cords can be added after the idealised solution is obtained.

How mechanical components can be constrained to move together

Systems of bodies in motion often contain cords or cables and pulleys used to connect the components and transmit or change the direction of force and motion.

It is common practice to neglect the weights and frictional resistances of cords and pulleys unless specific information is available to describe their effect.

In this section the discussion is limited to systems involving two separate masses connected in a way which forces them to move simultaneously and imposes a fixed ratio on the distances moved by each mass.

GIVE FEEDBACK

OK

Why are pulleys sometimes included in systems of bodies in motion?

Click the correct answer.

- To change the direction of force and motion
- To connect the components
- To apply a force to the system
- To apply a torque to an individual component
- To improve the appearance of the system

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Type your answer in the box.

Systems of bodies in motion often contain cords or ________ to connect the components.

They may also use ________ to change the direction of force and motion.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

What are typical methods used to connect the components in systems of bodies in motion?

Check all that apply.

- [ ] Cords
- [ ] Chains
- [ ] Cables
- [ ] Springs
- [ ] Magnetic fields

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

The force-acceleration method of solving problems involving a system of two bodies in linear motion

The **force-acceleration method** of solving problems for systems of bodies in motion consists of:

- Determining the relation between aspects of the motion of the two masses, which depends on how they are interconnected
- Considering each mass as a separate free body
- Producing a system of simultaneous equations
- Mathematically solving the simultaneous equations to find the unknown quantities

GIVE FEEDBACK

OK

Type your answer in the box.

The force-acceleration method of solving problems for systems of bodies in motion consists of:

- Determining the relation between aspects of the motion of the two masses, which depends on how they are ______
- Considering each mass as a separate ______ body
- Producing a system of ______ equations
- Mathematically ______ the simultaneous equations to find the unknown quantities

---

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Order the following steps that are required in order to use the force-acceleration method to analyse a system of bodies in motion.

↑↓ Place these in the proper order.

- Determine the relation between aspects of the motion of the two masses, which depends on how they are interconnected
- Consider each mass as a separate free body
- Produce a system of simultaneous equations
- Mathematically solve the simultaneous equations to find the unknown quantities

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Type your answer in the box.

The force-acceleration method of solving problems for systems of bodies in motion consists of:

- [ ] the relation between aspects of the motion of the two masses, which depends on how they are connected
- [ ] each mass as a separate free body
- [ ] a system of simultaneous equations
- [ ] solving the simultaneous equations to find the unknown quantities

---

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Match the following sentences that describe steps in the force-acceleration method of solving problems for systems of bodies in motion.

Drag statements on the right to match the left.

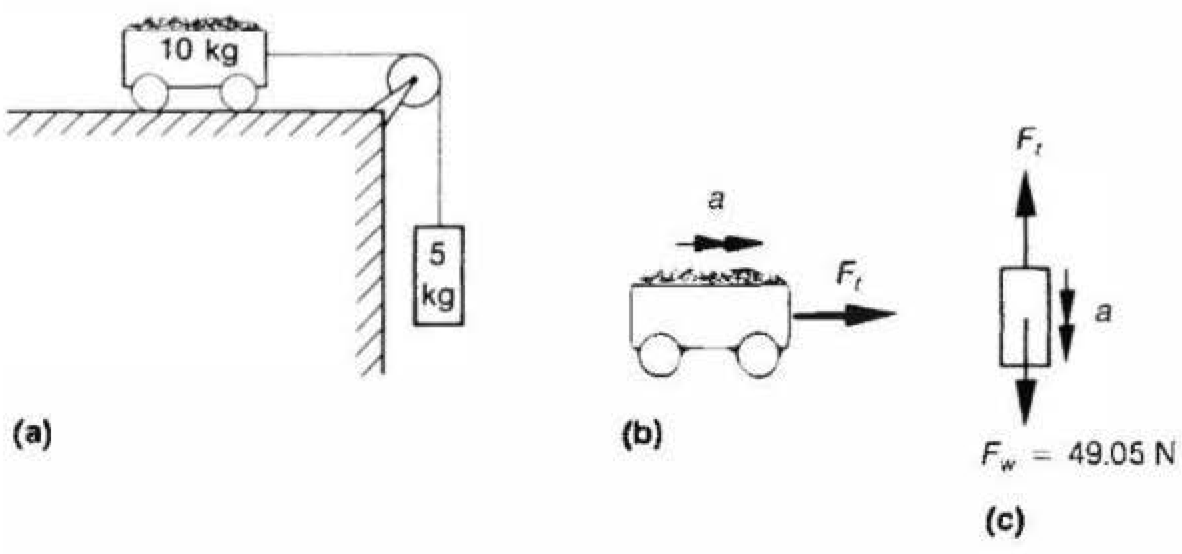
Determining the relation between aspects of the motion of the two masses,	which depends on how they are connected.
Considering each mass	as a separate free body.
Producing a system	of simultaneous equations.
Mathematically solving	the simultaneous equations to find the unknown quantities.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Simultaneous equations based on the force-acceleration relations for a system of two interconnected components

For the system of bodies shown in the figure determine the acceleration and the force in the cord.



Example	Interconnection	Analysis of the free body diagram for the 10 kg mass	Analysis of the free body diagram for the 5 kg mass	Solution

GIVE FEEDBACK

OK

Simultaneous equations based on the force-acceleration relations for a system of two interconnected components

When the 5 kg mass accelerates downwards in this system, the 10 kg mass will accelerate to the right at the same rate because they are connected by the cord running over the pulley.

Let us call this acceleration a.

Let us also call the tension in the cord F_t.

We are now ready to consider each mass as a separate free body.

Simultaneous equations based on the force-acceleration relations for a system of two interconnected components

For the $10\ \mathrm{kg}$ mass we can write:

$$F = m\,a$$

$$\text{or}\quad F_t = 10\ \mathrm{kg} \times a \qquad (1)$$

Example	Interconnection	Analysis of the free body diagram for the 10 kg mass	Analysis of the free body diagram for the 5 kg mass	Solution

GIVE FEEDBACK

OK

Simultaneous equations based on the force-acceleration relations for a system of two interconnected components

For the 5 kg mass, the net accelerating force is the difference between its weight and the tension in the cord.

Therefore $F = m a$ becomes:

$$F_w - F_t = m a$$

$$\text{or } 5 \times 9.81 - F_t = 5 \times a \quad (2)$$

Example	Interconnection	Analysis of the free body diagram for the 10 kg mass	Analysis of the free body diagram for the 5 kg mass	Solution

GIVE FEEDBACK

OK

Simultaneous equations based on the force-acceleration relations for a system of two interconnected components

Solving equations 1 and 2 yields:

$$a = 3.27 \text{ m/s}^2$$

and $F_t = 32.7 \text{ N}$

Example	Interconnection	Analysis of the free body diagram for the 10 kg mass	Analysis of the free body diagram for the 5 kg mass	Solution

A mass of 20 kg resting on a smooth horizontal table is connected, by an ideal string passing over a smooth pulley on the edge of the table, to a 10 kg mass hanging freely.

SMALL MEDIUM LARGE

Using a free body diagram for body A, which of the following is the correct equation that includes the tension in the cord (`F_t`) and the acceleration (`a`) of the body?

Click the correct answer.

- $F_t = 20a$
- $F_t = 98.1 - 10a$
- $F_t = 98.1 + 10a$
- $F_t = 98.1 - 20a$
- $F_t = 98.1 + 20a$
- $F_t = 10a$

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

A mass of 20 kg resting on a smooth horizontal table is connected, by an ideal string passing over a smooth pulley on the edge of the table, to a 10 kg mass hanging freely.

SMALL MEDIUM LARGE

Using a free body diagram for body B, which of the following is the correct equation that includes the tension in the cord (`F_t`), the weight force (correct to two decimal places) and the acceleration (`a`) of the body?

Click the correct answer.

$F_t = 98.1 - 10a$

$F_t = 98.1 + 10a$

$F_t = 98.1 - 20a$

$F_t = 98.1 + 20a$

$F_t = 20a$

$F_t = 10a$

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

A mass of 20 kg resting on a smooth horizontal table is connected, by an ideal string passing over a smooth pulley on the edge of the table, to a 10 kg mass hanging freely.

SMALL MEDIUM LARGE

Type your answer in the box.

Solving the simultaneous equations gives:

The acceleration of the bodies, a = ______ m/s (correct to two decimal places)

The tension in the string, F_t = ______ N (correct to one decimal place)

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

A mass of 10 kg resting on a smooth horizontal table is connected, by an ideal string passing over a smooth pulley on the edge of the table, to a 5 kg mass hanging freely.

SMALL | MEDIUM | LARGE

Using a free body diagram for body A, which of the following is the correct equation that includes the tension in the cord (`F_t`) and the acceleration (`a`) of the body?

Click the correct answer.

- $F_t = 10a$
- $F_t = 5a$
- $F_t = 49.05 - 5a$
- $F_t = 49.05 + 5a$
- $F_t = 49.05 - 10a$
- $F_t = 49.05 + 10a$

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

A mass of 10 kg resting on a smooth horizontal table is connected, by an ideal string passing over a smooth pulley on the edge of the table, to a 5 kg mass hanging freely.

SMALL MEDIUM LARGE

Using a free body diagram for body B, which of the following is the correct equation that includes the tension in the cord (`F_t`), the weight force (correct to three decimal places) and the acceleration (`a`) of the body?

Click the correct answer.

- $F_t = 49.05 - 5a$
- $F_t = 49.05 + 5a$
- $F_t = 49.05 - 10a$
- $F_t = 49.05 + 10a$
- $F_t = 10a$
- $F_t = 5a$

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

A mass of 10 kg resting on a smooth horizontal table is connected, by an ideal string passing over a smooth pulley on the edge of the table, to a 5 kg mass hanging freely.

SMALL MEDIUM LARGE

Type your answer in the box.

Solving the simultaneous equations gives:

The acceleration of the bodies, a = [ ] m/s (correct to two decimal places)

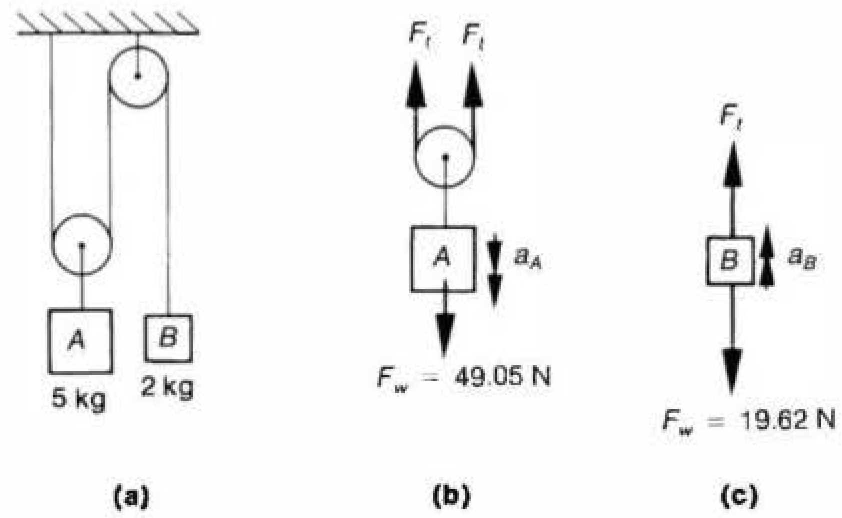
The tension in the string, F_t = [ ] N (correct to one decimal place)

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Determine the acceleration and force of tension in the cord connecting components

Determine the acceleration of bodies A and B, and the force of tension in the cord, for the system shown in the figure.



Example	Interconnection	Body B	Body A	Simplifying the simultaneous equations	Solving the simultaneous equations

GIVE FEEDBACK

OK

Determine the acceleration and force of tension in the cord connecting components

In this case, it is not immediately obvious in which direction motion will occur. This is decided by considering which body has a greater mass per fall of cord supporting it. This rule is based on the principle that the motion, if any, will take place in the direction of the external pull that produces the greatest static tension in the cord when all but one body in turn is held immovable while the static tension in the connecting cord is determined.

Body A is supported by two falls of cord and has a mass of $5\,\mathrm{kg}$, i.e. $2.5\,\mathrm{kg}$ per fall.

Body B has $2\,\mathrm{kg}$ per fall. Therefore body A will accelerate downwards and body B upwards.

The displacement of A will be half that of B.

Acceleration will be in the same ratio:

$$a_A = \frac{a_B}{2}$$

Example	Interconnection	Body B	Body A	Simplifying the simultaneous equations	Solving the simultaneous equations

GIVE FEEDBACK

OK

Determine the acceleration and force of tension in the cord connecting components

The free body diagram for body B gives:

$$F = m \times a$$
$$(F_t - F_{w_B}) = m_B \times a_B$$
$$F_t - 2 \times 9.81 = 2 a_B \qquad (1)$$

Example	Interconnection	Body B	Body A	Simplifying the simultaneous equations	Solving the simultaneous equations

GIVE FEEDBACK

OK

Determine the acceleration and force of tension in the cord connecting components

The free body diagram for body A gives:

$$F = m \times a$$
$$(F_{w_A} - 2F_t) = m_A \times a_A$$
$$5 \times 9.81 - 2F_t = 5 \times a_A$$

Substitute $a_A = \frac{a_B}{2}$:

$$5 \times 9.81 - 2F_t = \frac{5 \times a_B}{2} \qquad (2)$$

Example	Interconnection	Body B	Body A	Simplifying the simultaneous equations	Solving the simultaneous equations

GIVE FEEDBACK

OK

Determine the acceleration and force of tension in the cord connecting components

After equations 1 and 2 are simplified, we have:

$$F_t - 19.62 = 2\,a_B$$
$$49.05 - 2\,F_t = 2.5\,a_B$$

Example	Interconnection	Body B	Body A	Simplifying the simultaneous equations	Solving the simultaneous equations

GIVE FEEDBACK

OK

Determine the acceleration and force of tension in the cord connecting components

Multiplying the first equation by 2, and then adding the left-hand and right-hand sides respectively, eliminates F_t as follows:

$$2F_t - 39.24 + 49.05 - 2F_t = 4a_B + 2.5a_B$$
$$9.81 = 6.5a_B$$

Therefore:

$$a_B = \frac{9.81}{6.5} = 1.51\ \mathrm{m/s^2}$$

It follows that:

$$a_A = \frac{a_B}{2} = \frac{1.51}{2} = 0.755\ \mathrm{m/s^2}$$

and:

$$F_t = 2a_B + 19.62 = 2 \times 1.51 + 19.62 = 22.6\ \mathrm{N}$$

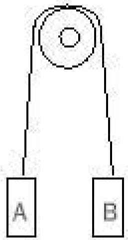
Example	Interconnection	Body B	Body A	Simplifying the simultaneous equations	Solving the simultaneous equations

GIVE FEEDBACK

OK

Two masses are suspended by an ideal string that passes over a smooth pulley:

- Mass A has a mass of 1 kg
- Mass B has a mass of 2 kg.



SMALL MEDIUM LARGE

By considering the free body diagram for mass *A*, which of the following is the correct equation that relates the tension in the string (`F_t`), the weight force of mass *A* (correct to two decimal places) and the acceleration (`a`)?

Click the correct answer.

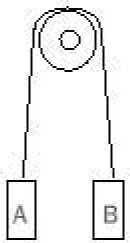
- $F_t - 9.81 = a$
- $F_t + 9.81 = a$
- $F_t - 19.62 = a$
- $F_t + 19.62 = a$
- $F_t = 9.81a$
- $F_t = 19.62a$

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Two masses are suspended by an ideal string that passes over a smooth pulley:

- Mass A has a mass of 1 kg
- Mass B has a mass of 2 kg.



SMALL MEDIUM LARGE

By considering the free body diagram for mass *B*, which of the following is the correct equation that relates the tension in the string (`F_t`), the weight force of mass *B* (correct to two decimal places) and the acceleration (`a`)?

Click the correct answer.

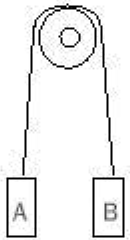
- $19.62 - F_t = 2a$
- $19.62 + F_t = 2a$
- $F_t - 9.81 = a$
- $F_t + 9.81 = a$
- $F_t = 9.81a$
- $F_t = 19.62a$

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Two masses are suspended by an ideal string that passes over a smooth pulley:

- Mass A has a mass of 1 kg
- Mass B has a mass of 2 kg.



SMALL MEDIUM LARGE

Type your answer in the box.

Solving the simultaneous equations gives:

The acceleration of the bodies, a = ______ m/s^2 (correct to two decimal places).

The tension in the string, F_t = ______ N (correct to two decimal places).

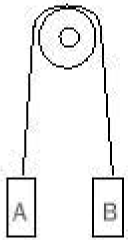
Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Two masses are suspended by an ideal string that passes over a smooth pulley.

Mass A has a mass of 2 kg.

Mass B has a mass of 4 kg.



SMALL MEDIUM LARGE

By considering the free body diagram for Mass A, which of the following is the correct equation that relates the tension in the string (`F_t`), the weight force of Mass A (correct to two decimal places) and the acceleration (`a`)?

Click the correct answer.

- $F_t = 19.62 + 2a$
- $F_t = 19.62 - 2a$
- $F_t = 39.24 + 4a$
- $F_t = 39.24 - 4a$
- $F_t = 4a$
- $F_t = 2a$

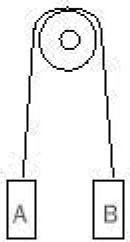
Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Two masses are suspended by an ideal string that passes over a smooth pulley.

Mass A has a mass of 2 kg.

Mass B has a mass of 4 kg.



SMALL MEDIUM LARGE

By considering the free body diagram for Mass B, which of the following is the correct equation that relates the tension in the string (`F_t`), the weight force of Mass B (correct to two decimal places) and the acceleration (`a`)?

Click the correct answer.

$F_t = 39.24 - 4a$

$F_t = 39.24 + 4a$

$F_t = 19.62 - 2a$

$F_t = 19.62 + 2a$

$F_t = 2a$

$F_t = 4a$

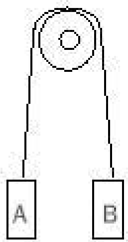
Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Two masses are suspended by an ideal string that passes over a smooth pulley.

Mass A has a mass of 2 kg.

Mass B has a mass of 4 kg.



SMALL MEDIUM LARGE

Type your answer in the box.

Solving the simultaneous equations gives:

The acceleration of the bodies, a = ______ m/s (correct to two decimal places).

The tension in the string, F_t = ______ N (correct to two decimal places).

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

The force-acceleration method of solving problems involving bodies containing rotating components

A cable drum that winds the cable around is an example of a system of bodies in rotational motion.

In considering systems of bodies in rotational motion, the discussion will be limited to a pair of components constrained to move simultaneously and connected in a way that imposes a definite relation between their motions.

The force-acceleration method of solving problems for systems of bodies in rotational motion consists of:

- Determining the relation between aspects of the motion of the two masses, which depends on how they are interconnected
- Considering each mass as a separate free body
- Producing a system of simultaneous equations
- Mathematically solving the simultaneous equations to find the unknown quantities

GIVE FEEDBACK

OK

Type your answer in the box.

The force-acceleration method of solving problems for systems of bodies in motion consists of:

- Determining the relation between aspects of the motion of the two masses, which depends on how they are [ ]
- Considering each mass as a separate [ ] body
- Producing a system of [ ] equations
- Mathematically [ ] the simultaneous equations to find the unknown quantities

---

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Match the following sentences that describe steps in the force-acceleration method of solving problems for systems of bodies in motion.

Drag statements on the right to match the left.

Determining the relation between aspects of the motion of the two masses,	which depends on how they are connected.
Considering each mass	as a separate free body.
Producing a system	of simultaneous equations.
Mathematically solving	the simultaneous equations to find the unknown quantities.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Order the following steps that are required in order to use the force-acceleration method to analyse a system of bodies in rotational motion.

↑↓ Place these in the proper order.

- Determining the relation between aspects of the motion of the two masses, which depends on how they are interconnected
- Considering each mass as a separate free body
- Producing a system of simultaneous equations
- Mathematically solving the simultaneous equations to find the unknown quantities

Do you know the answer?

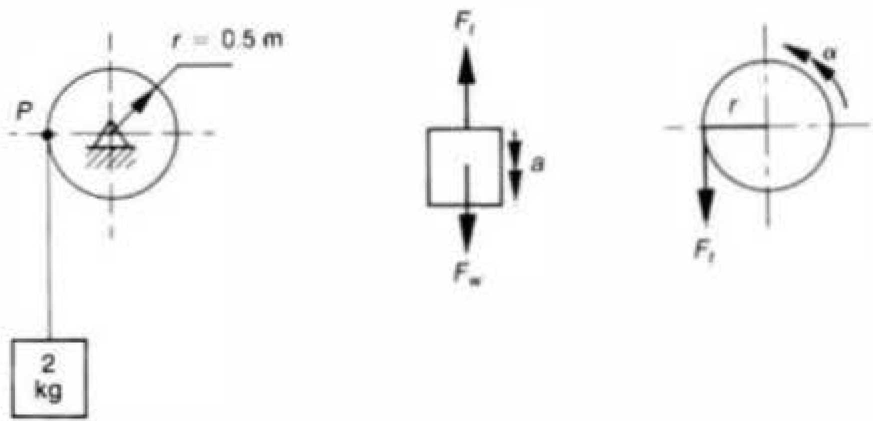
I KNOW IT | THINK SO | UNSURE | NO IDEA

An ideal cord or string connects the bodies in a fixed relationship but does not affect the calculations.

The relation between accelerations of two components that are constrained to move together

Example

The drum in Figure (a) below is attached to an ideal cord (light and inextensible). A mass of 2 kg is attached to the cord which is wrapped around the drum. Neglecting frictional resistance, identify the relationship between acceleration of the mass and the angular acceleration of the drum.



(a) (b) (c)

GIVE FEEDBACK

CONTINUE >

Solution

When the $2\ \mathrm{kg}$ mass accelerates downwards, the drum will accelerate in an anticlockwise direction at the rate related to the acceleration of the mass because they are connected by the cord.

Point P on the cord has an instantaneous linear acceleration a downwards and an angular acceleration. These are related by:

$$a = r\,\alpha$$

or

$$a = 0.5\,\alpha$$

< BACK GIVE FEEDBACK OK

A cable drum with a radius of 25 cm is attached to an ideal cord which is attached to a 5 kg mass.

Neglecting frictional resistance, identify the relationship between acceleration of the mass (a) and the angular acceleration (α) of the drum.

Clear

? Undo

Click and type your answer here

CHALLENGE SUBMIT SHOW ANSWER

A cable drum with a radius of 40 cm is attached to an ideal cord which is attached to a 10 kg mass.

Neglecting frictional resistance, identify the relationship between acceleration of the mass (a) and the angular acceleration (α) of the drum.

Click the correct answer.

$a = 0.4 \cdot \alpha$

$a = \frac{0.4}{\alpha}$

$a = 40 \cdot \alpha$

$a = \frac{40}{\alpha}$

Do you know the answer?

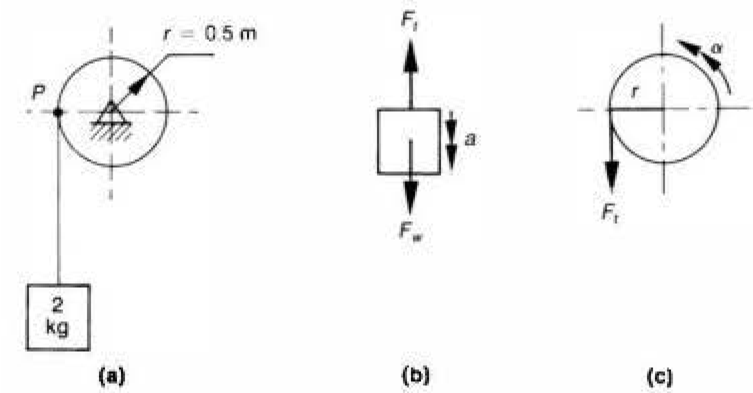
I KNOW IT | THINK SO | UNSURE | NO IDEA

Simultaneous equations based on the force-acceleration and/or torque-acceleration relation for two interconnected components

The drum in figure (a) has a mass moment of inertia of $25\ \mathrm{kg\,m^2}$.

A mass of $2\ \mathrm{kg}$ is attached to the cord which is wrapped around the drum.

Neglecting frictional resistance, use the free body diagrams in figures (b) and (c) to develop simultaneous equations for this system of bodies.



Example	Interconnection	Analysis of the free body diagram for the 2 kg mass	Analysis of the free body diagram for the drum	Summary of simultaneous equations

GIVE FEEDBACK

OK

Simultaneous equations based on the force-acceleration and/or torque-acceleration relation for two interconnected components

When the 2 kg mass accelerates downwards, the drum will accelerate in an anticlockwise direction at the rate related to the acceleration of the mass because they are connected by the cord.

Point P on the cord has an instantaneous linear acceleration a downwards and an angular acceleration α. These are related by:

$$a = r\,\alpha$$

$$\text{or } a = 0.5\,\alpha \qquad (1)$$

Example	Interconnection	Analysis of the free body diagram for the 2 kg mass	Analysis of the free body diagram for the drum	Summary of simultaneous equations

GIVE FEEDBACK

OK

Simultaneous equations based on the force-acceleration and/or torque-acceleration relation for two interconnected components

For the 2 kg mass as a free body we can write:

$$F = m\,a$$
$$F_w - F_t = m\,a$$

where:

F_w is the weight, i.e. $2\ \mathrm{kg} \times 9.81\ \mathrm{N/kg} = 19.62\ \mathrm{N}$

F_t is the tension in the cord

Therefore:

$$19.62 - F_t = 2\,a \qquad (2)$$

Example	Interconnection	Analysis of the free body diagram for the 2 kg mass	Analysis of the free body diagram for the drum	Summary of simultaneous equations

Simultaneous equations based on the force-acceleration and/or torque-acceleration relation for two interconnected components

Likewise for the drum we write:

$$T = I\,\alpha$$

where:

T is the torque, i.e. $F_t \times r = F_t \times 0.5$

$I = 25\ \text{kg.m}^2$

Therefore:

$$F_t \times 0.5 = 25\,\alpha \qquad (3)$$

Example	Interconnection	Analysis of the free body diagram for the 2 kg mass	Analysis of the free body diagram for the drum	Summary of simultaneous equations

GIVE FEEDBACK

OK

Simultaneous equations based on the force-acceleration and/or torque-acceleration relation for two interconnected components

$$a = 0.5\,\alpha \qquad (1)$$

$$19.62 - F_t = 2a \qquad (2)$$

$$F_t \times 0.5 = 25\,\alpha \qquad (3)$$

Example	Interconnection	Analysis of the free body diagram for the 2 kg mass	Analysis of the free body diagram for the drum	Summary of simultaneous equations

A winch drum with a radius of $0.4\,\mathrm{m}$ has a mass moment of inertia of $6\,\mathrm{kg\,m^2}$. A mass of $5\,\mathrm{kg}$ is attached to the cord which is wrapped around the drum.

Neglecting frictional resistance and assuming the mass is accelerating downwards, use free body diagrams for the drum and the mass to develop simultaneous equations for this system of bodies.

SMALL MEDIUM LARGE

Develop the equation for the relationship between the angular acceleration (α) of the drum and the linear acceleration (a) of the 5 kg mass.

Clear

Undo

Click and type your answer here

CHALLENGE SUBMIT SHOW ANSWER

A winch drum with a radius of $0.4\,\mathrm{m}$ has a mass moment of inertia of $6\,\mathrm{kg\,m^2}$. A mass of $5\,\mathrm{kg}$ is attached to the cord which is wrapped around the drum.

Neglecting frictional resistance and assuming the mass is accelerating downwards, use free body diagrams for the drum and the mass to develop simultaneous equations for this system of bodies.

SMALL MEDIUM LARGE

Using a free body diagram for the 5 kg mass, develop an equation that relates the acceleration (a), the tension in the cord (F_t) and the weight force of the mass (correct to two decimal places).

+ − · ÷ Clear

? Undo

Click and type your answer here

CHALLENGE SUBMIT SHOW ANSWER

A winch drum with a radius of $0.4\,\mathrm{m}$ has a mass moment of inertia of $6\,\mathrm{kg\,m^2}$. A mass of $5\,\mathrm{kg}$ is attached to the cord which is wrapped around the drum.

Neglecting frictional resistance and assuming the mass is accelerating downwards, use free body diagrams for the drum and the mass to develop simultaneous equations for this system of bodies.

SMALL MEDIUM LARGE

Using a free body diagram for the drum, develop an equation that relates the angular acceleration (α) and the tension in the cord (F_t).

Clear

?

Undo

Click and type your answer here

CHALLENGE SUBMIT SHOW ANSWER

A winch drum with a radius of $25\ \mathrm{cm}$ has a mass moment of inertia of $8\ \mathrm{kg\,m^2}$. A mass of $10\ \mathrm{kg}$ is attached to the cord which is wrapped around the drum.

Neglecting frictional resistance and assuming that the mass is accelerating downwards, use free body diagrams for the drum and the mass to develop simultaneous equations for this system of bodies.

SMALL MEDIUM LARGE

Develop the equation for the relationship between the angular acceleration (α) of the drum and the linear acceleration (a) of the 10 kg mass.

+ − · ÷ Clear

? Undo

Click and type your answer here

CHALLENGE SUBMIT SHOW ANSWER

A winch drum with a radius of $25\ \mathrm{cm}$ has a mass moment of inertia of $8\ \mathrm{kg\,m}^2$. A mass of $10\ \mathrm{kg}$ is attached to the cord which is wrapped around the drum.

Neglecting frictional resistance and assuming that the mass is accelerating downwards, use free body diagrams for the drum and the mass to develop simultaneous equations for this system of bodies.

SMALL MEDIUM LARGE

Using a free body diagram for the 10 kg mass, develop an equation that relates the acceleration (a), the tension in the cord (F_t) and the weight force of the mass (correct to one decimal place).

Clear

Undo

Click and type your answer here

CHALLENGE SUBMIT SHOW ANSWER

A winch drum with a radius of $25\ \mathrm{cm}$ has a mass moment of inertia of $8\ \mathrm{kg\,m^2}$. A mass of $10\ \mathrm{kg}$ is attached to the cord which is wrapped around the drum.

Neglecting frictional resistance and assuming that the mass is accelerating downwards, use free body diagrams for the drum and the mass to develop simultaneous equations for this system of bodies.

SMALL MEDIUM LARGE

Using a free body diagram for the drum, develop an equation that relates the angular acceleration (α) and the tension in the cord (F_t).

+ − · ÷ Clear

? Undo

Click and type your answer here

CHALLENGE SUBMIT SHOW ANSWER

Determine the time, acceleration and force/tension in cord connecting components

The drum in figure (a) has a mass moment of inertia of $25\ \mathrm{kg.m^2}$. A mass of $2\ \mathrm{kg}$ is attached to the cord which is wrapped around the drum. Neglecting frictional resistance, solve the given simultaneous equations and determine the time taken for the mass to drop 2 m after being released from rest, and the tension in the cord.

$$a = 0.5\,\alpha \qquad (1)$$

$$19.62 - F_t = 2a \qquad (2)$$

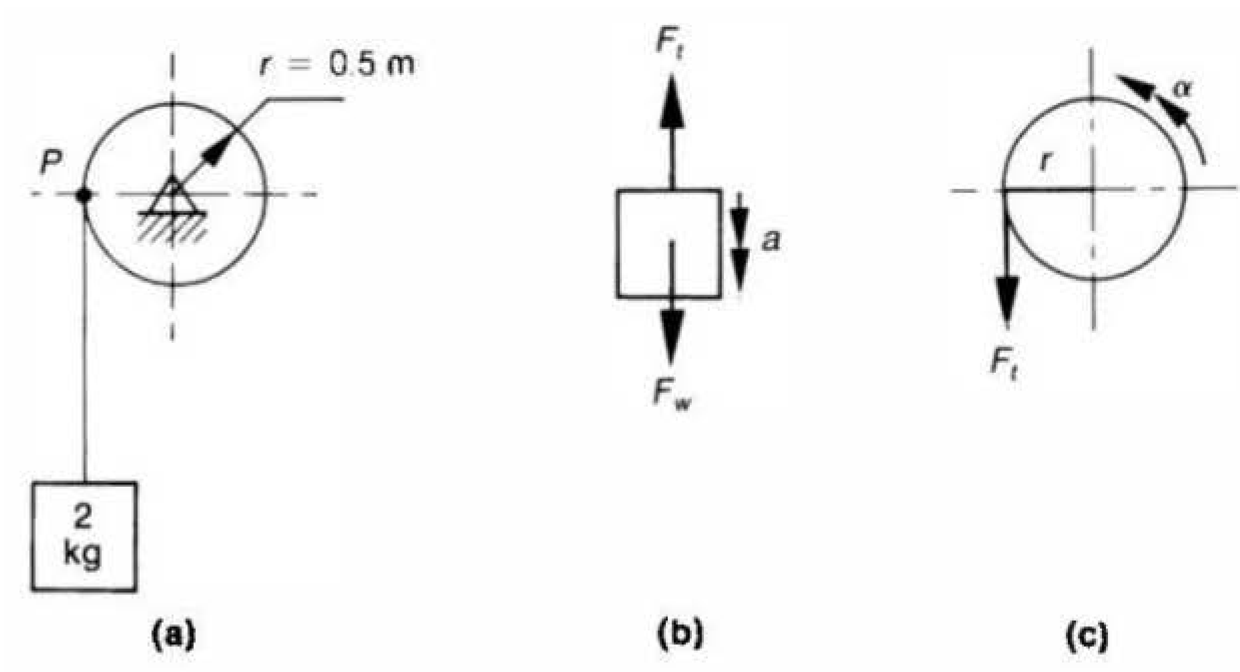
$$F_t \times 0.5 = 25\,\alpha \qquad (3)$$

Example	Figure	Solve the simultaneous equations	Find the time taken

GIVE FEEDBACK

OK

Determine the time, acceleration and force/tension in cord connecting components



Example	Figure	Solve the simultaneous equations	Find the time taken

GIVE FEEDBACK

OK

Determine the time, acceleration and force/tension in cord connecting components

The simultaneous equations can be solved by, for example, substitution of $a = 0.5\,\alpha$ from equation 1 into equation 2:

$$19.62 - F_t = 2 \times (0.5\,\alpha)$$

Now divide this new equation by equation 3:

$$\frac{19.62 - F_t}{0.5\,F_t} = \frac{2 \times 0.5\,\alpha}{25\,\alpha}$$

Simplifying and solving for F_t gives the tension:

$$F_t = 19.24\,\mathrm{N}$$

Substituting back into equation 2 gives:

$$19.62 - 19.24 = 2\,a$$
$$\therefore a = 0.192\,\mathrm{m/s^2}$$

Example	Figure	Solve the simultaneous equations	Find the time taken

GIVE FEEDBACK

OK

Determine the time, acceleration and force/tension in cord connecting components

Now $S = v_0 t + \frac{1}{2} a t^2$ can be used to solve for time taken since the distance dropped is $S = 2\,\mathrm{m}$ and the initial velocity is zero:

$$2 = 0 + \frac{1}{2} 0.192\, t^2$$

Hence:

the time taken is 4.56 seconds.

Example	Figure	Solve the simultaneous equations	Find the time taken

GIVE FEEDBACK

OK

A winch drum with a radius of $0.4\,\mathrm{m}$ has a mass moment of inertia of $6\,\mathrm{kg\,m^2}$. A mass of $5\,\mathrm{kg}$ is attached to the cord which is wrapped around the drum.

Neglecting frictional resistance, solve the given simultaneous equations and determine the time taken for the mass to drop 3 m after being released from rest, and the tension in the cord.

$a = 0.4\alpha$ (1)

$49.05 - F_t = 5a$ (2)

$0.4F_t = 6\alpha$ (3)

SMALL MEDIUM LARGE

Type your answer in the box.

The tension force in the cord is ______ N.

(Answer correct to three decimal places.)

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

A winch drum with a radius of $0.4\,\mathrm{m}$ has a mass moment of inertia of $6\,\mathrm{kg\,m^2}$. A mass of $5\,\mathrm{kg}$ is attached to the cord which is wrapped around the drum.

Neglecting frictional resistance, solve the given simultaneous equations and determine the time taken for the mass to drop 3 m after being released from rest, and the tension in the cord.

$a = 0.4\alpha$ (1)

$49.05 - F_t = 5a$ (2)

$0.4F_t = 6\alpha$ (3)

SMALL MEDIUM LARGE

Type your answer in the box.

The acceleration of the mass is ______ m/s^2.

(Answer correct to three decimal places.)

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

A winch drum with a radius of $0.4\,\mathrm{m}$ has a mass moment of inertia of $6\,\mathrm{kg\,m^2}$. A mass of $5\,\mathrm{kg}$ is attached to the cord which is wrapped around the drum.

Neglecting frictional resistance, solve the given simultaneous equations and determine the time taken for the mass to drop 3 m after being released from rest, and the tension in the cord.

$a = 0.4\alpha$ (1)

$49.05 - F_t = 5a$ (2)

$0.4F_t = 6\alpha$ (3)

SMALL MEDIUM LARGE

Type your answer in the box.

The time taken to drop 3 m is ______ s.

(Answer correct to three decimal places).

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

A winch drum with a radius of $25\,\text{cm}$ has a mass moment of inertia of $8\,\text{kg}\,\text{m}^2$. A mass of $10\,\text{kg}$ is attached to the cord which is wrapped around the drum.

Neglecting frictional resistance, solve the given simultaneous equations and determine the time taken for the mass to drop 3 m after being released from rest, and the tension in the cord.

$a = 0.25\,\alpha$ (1)

$98.1 - F_t = 10\,a$ (2)

$0.25\,F_t = 8\,\alpha$ (3)

SMALL MEDIUM LARGE

Type your answer in the box.

The tension force in the cord is [ ] N.

(Answer correct to three decimal places).

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

A winch drum with a radius of 25 cm has a mass moment of inertia of 8 kg m^2. A mass of 10 kg is attached to the cord which is wrapped around the drum.

Neglecting frictional resistance, solve the given simultaneous equations and determine the time taken for the mass to drop 3 m after being released from rest, and the tension in the cord.

$a = 0.25\alpha$ (1)

$98.1 - F_t = 10a$ (2)

$0.25F_t = 8\alpha$ (3)

SMALL MEDIUM LARGE

Type your answer in the box.

The acceleration of the mass is ______ m/s^2.

(Answer correct to three decimal places).

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

A winch drum with a radius of 25 cm has a mass moment of inertia of 8 kg m². A mass of 10 kg is attached to the cord which is wrapped around the drum.

Neglecting frictional resistance, solve the given simultaneous equations and determine the time taken for the mass to drop 3 m after being released from rest, and the tension in the cord.

$a = 0.25\alpha$ (1)

$98.1 - F_t = 10a$ (2)

$0.25F_t = 8\alpha$ (3)

SMALL MEDIUM LARGE

Type your answer in the box.

The time taken to drop 3 metres is ______ seconds.

(Answer correct to three decimal places).

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA