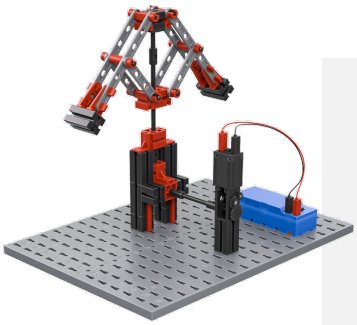
STEM MECHANICS - TASKS

Model 20
Centrifugal force



Date

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Centrifugal force, also known as centrifugal force, is caused by the inertia of a body during rotational or circular movements. It acts radially outward from the axis of rotation. We often experience it in everyday life: on a chain carousel, the seats are pushed outward; in a salad spinner, the water flies outward; and a cyclist has to lean into the curve to compensate for the force.

DESIGN TASK

Build the model according to the instructions.

Its design corresponds to a so-called centrifugal governor. In 1788, MATTHEW BOULTON discovered the centrifugal governor while building windmills. It is a control instrument that uses centrifugal force to regulate the speed of a machine. Together with JAMES WATT, he then used the centrifugal governor to regulate the speed of steam engines.

THEMATIC TASK

1. Wherever circular movements occur, centrifugal force is also at work. The faster a curve is driven through and the tighter the curve, the greater the centrifugal force. What two options does the driver have to reduce centrifugal force?

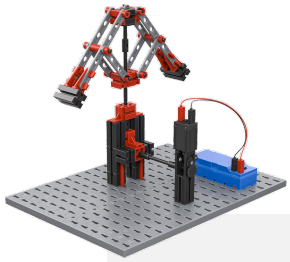
_____

_____

_____

2. Which formula describes the calculation of centrifugal force with speed?

   a) $F = m * a$
   b) $F = m * \frac{v2}{r}$
   c) $F = m * r * w^2$



THEMATIC TASK

Wherever circular motion occurs, centrifugal force is also at work. Centrifugal force increases with the speed at which a curve is driven through and the tightness of the curve. What two options does the driver have for reducing centrifugal force?

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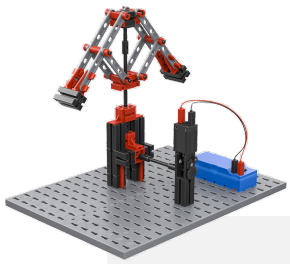
Which formula describes the calculation of centrifugal force based on speed?

a) $F = m \bullet a$
b) $F = m \bullet \frac{v2}{r}$
c) $F = m \bullet r \bullet w^2$

Centrifugal force can be calculated in two other ways. You can either calculate it using radial acceleration or angular velocity. Do you know the formulas?

Radial acceleration formula:

Angular velocity formula:



3. Centrifugal force can be calculated in two other ways. You can either calculate it using radial acceleration or angular velocity. Do you know the formulas?

Radial acceleration formula: _____

Angular velocity formula: _____

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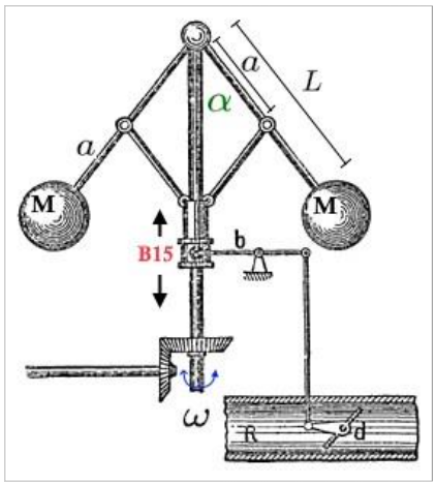
EXPERIMENTAL TASK

1. Turn the crank on the model and slowly increase the speed.

What can you observe? How does component 15 (B15) behave along the axis of rotation as the speed (ω) increases?

a) B15 lowers
b) B15 rises



Wattscher Regulator

2. What happens to the angular width α as the speed (ω) increases?

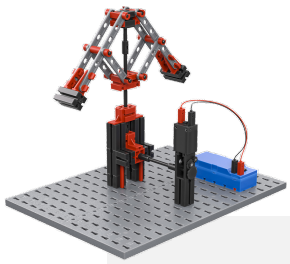
a) α becomes larger
b) α becomes smaller

3. What would happen to B15 if the weights M were increased while the rotational speed ω remained constant?

a) B15 lowers
b) B15 rises

4. What happens to the angular width α if the weights M are increased while the rotational speed ω remains constant?

a) α becomes larger
b) α becomes smaller



5. James Watt used the centrifugal governor to keep the working speed of his improved steam engine constant. Can you explain how it works?

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APPENDICES

Assembly instructions and templates for the models:
Model 20: Building instructions for centrifugal governor model.

Further information

[1] Wikipedia: Centrifugal force

[2] LeifiPhysik: Centrifugal governor

[3] studyflix: Centrifugal force