Erasmus+

Development of innovative training solutions in the field of functional evaluation aimed at updating of the curricula of health sciences schools

MODUL BIOMECHANIK GRUNDLAGEN

Didaktische Einheit B: KRÄFTE UND DRUCK

Politechnika Śląska

IBV INSTITUTO DE BIOMECÁNICA DE VALENCIA

VNIVERSITAT DE VALÈNCIA

AMSE THE ASSOCIATION OF MEDICAL SCHOOLS IN EUROPE

KLASSENINDEX

- Grundlegende kinetische Größen

- Testen Sie Ihr Wissen über kinetische Gleichungen

GRUNDLEGENDE KINETISCHE GLEICHUNGEN

Die Kinetik beantwortet die Frage, warum sich ein Körper bewegt

Kraft ist die physikalische Größe, mit der die Ursachen für die Veränderungen der Bewegung von Körpern quantifiziert werden.

Energie ist ein Maß für die Fähigkeit von jemandem oder etwas, Arbeit zu verrichten.

Kinetische Energie : Energie, die ein Objekt aufgrund seiner Bewegung besitzt.

$$Kinetic\ Energy: \frac{1}{2}mv^2$$

Potentielle Energieist Energie, die aus der Position oder Konfiguration resultiert.

$$Potential\ Energy = mgh$$

Arbeit*:* Eine Kraft verrichtet Arbeit, wenn bei ihrer Einwirkung eine Bewegung des Angriffspunktes in Richtung der Kraft erfolgt (gleiche Richtung oder die Kraft hat eine Komponente in Richtung der Bewegung).

$$Work = F\Delta dcos\emptyset$$

Leistung ist definiert als die Rate der Verrichtung von Arbeit oder die Rate der Nutzung von Energie.

$$Power = \frac{Work}{time} = \frac{Force * distance *}{time} = Force * velocity$$

Das **Drehmoment** ist definiert durch die Messung der Verdrehung, die durch eine Kraft verursacht wird, die ein Objekt zur Drehung um eine Achse veranlassen kann.

$$Torque(\tau) = F * r * sin\theta$$

KINETISCHE GLEICHUNGEN ÜBUNGEN

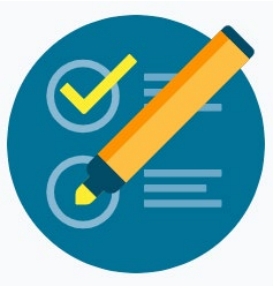
Kinetische Energie

https://www.khanacademy.org/science/ap-physics-1/ap-work-and-energy/kinetic-energy-ap/e/kinetic-energy-exercises-ap1?modal=1

Änderungen der potenziellen Gravitationsenergie finden

https://www.khanacademy.org/science/ap-physics-1/ap-work-and-energy/conservative-forces-and-gravitational-potential-energy-ap/e/gravitational-potential-energy-ap-physics-1?modal=1

KINETISCHE GLEICHUNGEN ÜBUNGEN



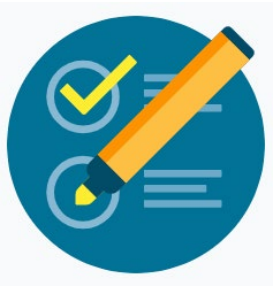
Von einer Kraft verrichtete Arbeit

https://www.khanacademy.org/science/ap-physics-1/ap-work-and-energy/introduction-to-work-ap/e/work-equation-ap-physics-1?modal=1

Torque

https://www.khanacademy.org/science/ap-physics-1/ap-torque-angular-momentum/torque-and-equilibrium-ap/e/torque-calculations-ap-physics-1

KINETISCHE GLEICHUNGEN ÜBUNGEN



Kinetische Energie

ANFRAGE 1

A $2.0\,\text{kg}$ guinea pig runs at a speed of $1.0\,\frac{\text{m}}{\text{s}}$.

What is the guinea pig's kinetic energy?

Round answer to two significant digits.

_____ J

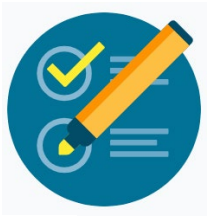
ANFRAGE 2

A elephant kicks a $5.0\,\text{kg}$ stone with $150\,\text{J}$ of kinetic energy.

What is the stone's speed?

Round answer to two significant digits.

_____ $\frac{\text{m}}{\text{s}}$



KINETISCHE GLEICHUNGEN LÖSUNGEN

Kinetic Energy

FRAGE 1: LÖSUNG

Let's use the kinetic energy equation.

$$K = \frac{1}{2}mv^2$$

$$= \frac{1}{2}(2.0\,\text{kg})(1.0\,\frac{\text{m}}{\text{s}})^2$$

$$= 1.0\,\frac{\text{kg}\cdot\text{m}^2}{\text{s}^2}$$

$$= 1.0\,\text{J}$$

The correct answer is $1.0\,\text{J}$.

Let's use the kinetic energy equation and solve for speed, v.

$$K = \frac{1}{2}mv^2$$

$$v^2 = \frac{2K}{m}$$

FRAGE 2: LÖSUNG

$$v = \sqrt{\frac{2K}{m}}$$

$$= \sqrt{\frac{2(150\,\text{J})}{5.0\,\text{kg}}}$$

$$= \sqrt{\frac{2\left(150\,\frac{\text{kg}\cdot\text{m}^2}{\text{s}^2}\right)}{5.0\,\text{kg}}}$$

$$= \sqrt{60\frac{\text{m}^2}{\text{s}^2}}$$

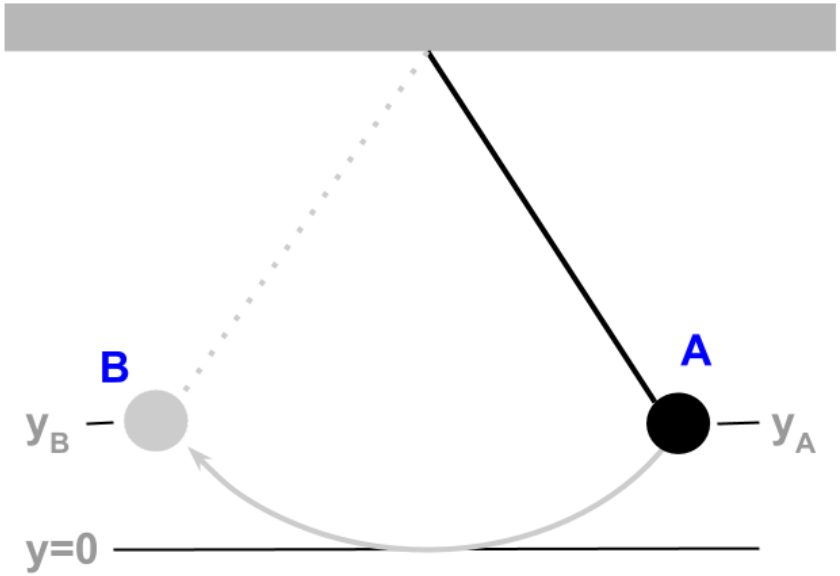
$$= 7.7\,\frac{\text{m}}{\text{s}}$$

The correct answer is $7.7\,\frac{\text{m}}{\text{s}}$.

KINETISCHE GLEICHUNGEN ÜBUNGEN

Änderungen der potenziellen Gravitationsenergie finden

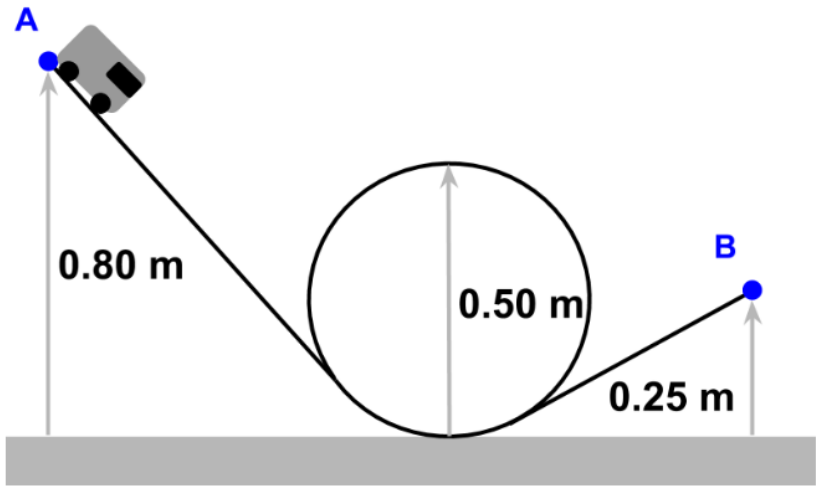
A $1.5\,\text{kg}$ pendulum swings from point A of height $y_A = 0.10\,\text{m}$ to point B of the same height. The heights are relative to the lowest height.



What is the change in gravitational potential energy from A to B?

FRAGE 3

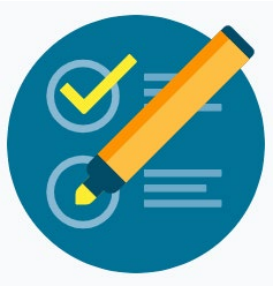
A $1.0\,\text{kg}$ toy car is released at the top of a frictionless track on the left and rolls off of the track from its right side ramp. The car starts at a height of $0.80\,\text{m}$, goes through a $0.50\,\text{m}$ diameter loop, and exits the ramp at a height of $0.25\,\text{m}$.



What is the change in the car's gravitational potential energy from A to B?

Round answer to two significant digits.

FRAGE 4



KINETISCHE GLEICHUNGEN LÖSUNGEN

Änderungen der potenziellen Gravitationsenergie finden

The change in gravitational potential energy ΔU_g only depends on the relative heights at A and B.

The height above the lowest height is $y_A = 0.10\,\text{m}$ at A and $y_B = 0.10\,\text{m}$ at B.

Since the height doesn't change, Δy is zero and ΔU_g is also zero.

The correct answer is $0\,\text{J}$.

FRAGE 3: LÖSUNG

The change in gravitational potential energy ΔU_g only depends on the relative heights at A and B.

The height above the ground is $y_A = 0.80\,\text{m}$ at A and $y_B = 0.25\,\text{m}$ at B.

We can use these heights to find ΔU_g of the car.

$$\Delta U_g = mg\Delta y$$

$$= mg(y_B - y_A)$$

$$= (1.0\,\text{kg})\left(9.8\,\frac{\text{m}}{\text{s}^2}\right)(0.25\,\text{m} - 0.80\,\text{m})$$

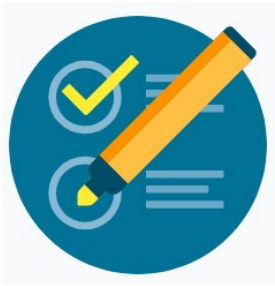
$$= -5.4\,\text{kg}\cdot\frac{\text{m}^2}{\text{s}^2}\left(\frac{1\,\text{J}}{1\,\text{kg}\cdot\frac{\text{m}^2}{\text{s}^2}}\right)$$

$$= -5.4\,\text{J}$$

FRAGE 4: LÖSUNG

The correct answer is $-5.4\,\text{J}$.

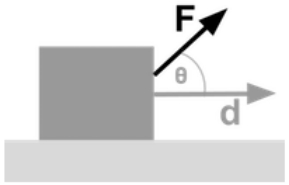
KINETISCHE GLEICHUNGEN ÜBUNGEN



Von einer Kraft verrichtete Arbeit

FRAGE 5

A box moves $5\,\mathrm{m}$ horizontally when force $F = 10\,\mathrm{N}$ is applied at an angle $\theta = 30^\circ$.



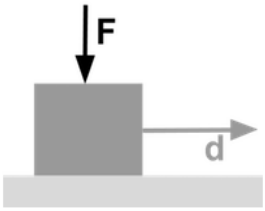
What is the work done on the box by F during the displacement?

Choose 1 answer:

- (A) $50\,\mathrm{J}$
- (B) $-43\,\mathrm{J}$
- (C) $-50\,\mathrm{J}$
- (D) $43\,\mathrm{J}$

FRAGE 6

A box moves $1000\,\mathrm{m}$ horizontally as a force $F = 2000\,\mathrm{N}$ is applied downward.

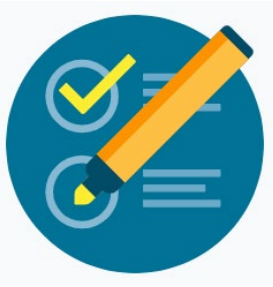


What is the work done on the box by F during the displacement?

Choose 1 answer:

- (A) $2,000,000\,\mathrm{J}$
- (B) $2000\,\mathrm{J}$
- (C) $-2,000,000\,\mathrm{J}$
- (D) $0\,\mathrm{J}$

KINETISCHE GLEICHUNGEN LÖSUNGEN



Von einer Kraft verrichtete Arbeit

FRAGE 5: LÖSUNG

We can use the work equation to determine the work W done by F. Only the component of force parallel to the displacement does work.

$$W = Fd\cos\theta$$

$$W = Fd\cos\theta$$

$$= (10\,\mathrm{N})(5\,\mathrm{m})\cos(30^\circ)$$

$$\approx 43\,\mathrm{N}\cdot\mathrm{m}$$

$$\approx 43\,\mathrm{J}$$

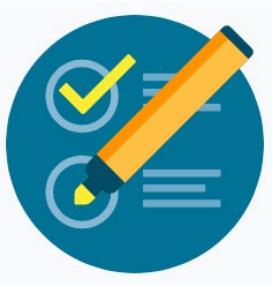
The answer is $43\ \mathrm{J}$.

FRAGE 6: LÖSUNG

Only force parallel with the displacement does work. The force F is perpendicular with the displacement, so it does zero work on the box.

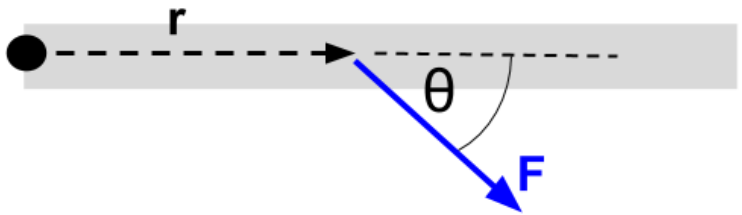
The answer is $0\,\mathrm{J}$

KINETISCHE GLEICHUNGEN ÜBUNGEN



Drehmoment

A $25\ \mathrm{N}$ force F is applied to a bar that can pivot around its end as shown below.



The force is $r = 0.75\ \mathrm{m}$ away from the end and at an angle $\theta = 60^\circ$.

What is the torque on the bar?

Answer using a coordinate system where counterclockwise is positive.

FRAGE 7

A $25\ \mathrm{N}$ force F is applied to a bar that can pivot around its end as shown below.

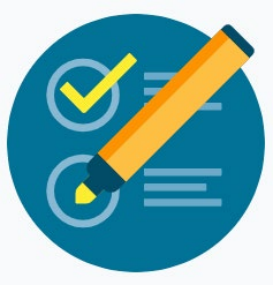
The force is parallel to the bar and is $r = 0.75\ \mathrm{m}$ away from the end.

What is the torque on the bar?

Answer using a coordinate system where counterclockwise is positive.

FRAGE 8

KINETISCHE GLEICHUNGEN LÖSUNGEN



Drehmoment

FRAGE 7: LÖSUNG

The applied force rotates the bar clockwise around the end. Thus, the torque is clockwise and negative.

We can determine the magnitude using:

$$\tau = rF\sin\theta$$

Let's substitute our known values to solve for the magnitude of τ.

$$\tau = rF\sin\theta$$

$$= (0.75\,\mathrm{m})(25\,\mathrm{N})\sin 60^\circ$$

$$= 16\,\mathrm{N}\cdot\mathrm{m}$$

Since the direction is negative, the torque is $-16\,\mathrm{N}\cdot\mathrm{m}$.

The correct answer is $-16\,\mathrm{N}\cdot\mathrm{m}$.

FRAGE 8: LÖSUNG

We can determine the magnitude of torque using:

$$\tau = rF\sin\theta$$

Since F is parallel to the lever arm and θ is zero, the force produces zero torque.

The correct answer is $0\,\mathrm{N}\cdot\mathrm{m}$.

Erasmus+

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