10 Physics: Torque

Curriculum: A levels

Material Slides

Slide 1: Introduction

- Torque is a rotational force that causes an object to rotate around an axis.
- It is denoted by the symbol τ and is measured in Newton-meters (Nm) or Joules (J).

Slide 2: Torque Equation

- The torque equation is given by $\tau = r * F * \sin(\theta)$, where:
  - τ is the torque,
  - r is the distance from the axis of rotation to the point where the force is applied,
  - F is the force applied, and
  - θ is the angle between the force vector and the lever arm.

Slide 3: Direction of Torque

- Torque is a vector quantity that follows the right-hand rule:
  - If the torque is counterclockwise, it is considered positive.
  - If the torque is clockwise, it is considered negative.

Slide 4: Moment Arm

- The moment arm is the perpendicular distance between the axis of rotation and the line of actio
- A longer moment arm results in a greater torque for the same force.

Slide 5: Lever Arm

- The lever arm is another term for the moment arm in rotational motion.
- It determines the mechanical advantage of a lever system.

Slide 6: Torque and Angular Acceleration

- The relationship between torque and angular acceleration is given by $\tau = I * \alpha$, where:
  - τ is the torque,
  - I is the moment of inertia of the object, and
  - α is the angular acceleration.

Slide 7: Moment of Inertia

- The moment of inertia, I, measures an object's resistance to changes in rotational motion.
- It depends on the mass distribution and the shape of the object.

Slide 8: Equilibrium and Torque

- An object is in rotational equilibrium when the sum of the torques acting on it is zero.
- Mathematically, $\Sigma\tau = 0$, where $\Sigma\tau$ is the total torque.

Slide 9: Applications of Torque
- Torque is essential in various applications, including:
  - Opening a door with a handle,
  - Using a wrench to tighten a bolt, and
  - Rotating a merry-go-round.

Slide 10: Conclusion
- Torque plays a crucial role in rotational motion, affecting how objects move and interact around
- Understanding the principles of torque is essential for analyzing and predicting the behavior of r

Practice Problems

1. Practice Problem:

Calculate the torque exerted by a force of 50 N applied at a distance of 0.2 meters from the pivot

Solution:

Torque = force × distance

Torque = 50 N × 0.2 m

Torque = 10 Nm

2. Practice Problem:

A lever is 1.5 meters long with a force of 30 N applied at one end. Calculate the torque produced

Solution:

Torque = force × lever arm

Torque = 30 N × 1.5 m

Torque = 45 Nm

3. Practice Problem:

If a force of 100 N is applied at an angle of 30 degrees to a wrench that is 0.3 meters long, what i

Solution:

Torque = force × lever arm × sin(angle)

Torque = 100 N × 0.3 m × sin(30)

Torque = 100 N × 0.3 m × 0.5

Torque = 15 Nm

4. Practice Problem:

A car tire lug nut is tightened with a torque of 80 Nm. If a wrench 0.25 meters long is used, what f

Solution:

Force = Torque / lever arm

Force = 80 Nm / 0.25 m

Force = 320 N

5. Practice Problem:

What is the minimum force required to lift a 500 N object using a pulley system with a lever arm o

Solution:

Force_required = Weight × Lever arm

Force_required = 500 N × 0.4 m

Force_required = 200 N

6. Practice Problem:

A seesaw has one person weighing 60 kg sitting on one end, and another person weighing 80 kg

Solution:

(60 kg)(2 m) = (80 kg)(x)

120 kg*m = 80 kg(x)

x = 1.5 m

7. Practice Problem:

A force of 120 N is applied to a wrench 0.25 meters long at an angle of 60 degrees. Calculate the

Solution:

Torque = force × lever arm × sin(angle)

Torque = 120 N × 0.25 m × sin(60)

Torque = 120 N × 0.25 m × 0.866

Torque = 26 Nm

8. Practice Problem:

A lever is 1.8 meters long and a force of 40 N is applied at an angle of 45 degrees to the lever. C

Solution:

Torque = force × lever arm × sin(angle)

Torque = 40 N × 1.8 m × sin(45)

Torque = 40 N × 1.8 m × 0.707

Torque = 51 Nm

9. Practice Problem:

If the lever arm is doubled while the force remains constant, how does the torque change?

Solution:

Since Torque = force × lever arm, doubling the lever arm will double the torque, assuming the for

10. Practice Problem:

Calculate the torque required to open a door if a force of 15 N is applied perpendicular to the doo

Solution:

Torque = force × distance

Torque = 15 N × 0.8 m

Torque = 12 Nm

References

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