

Stop motion armature machining a construction man Printable PDF

Stop motion armature machining a construction man is an intricate process that combines craftsmanship, engineering, and artistic vision to bring animated characters to life. Whether you're a seasoned stop motion animator or a hobbyist eager to learn, understanding how to machine a construction man armature is essential for creating durable, flexible, and realistic figures. This article explores the detailed steps involved in armature machining, focusing on designing, selecting materials, machining techniques, assembly, and finishing touches to ensure your construction man comes alive smoothly in your stop motion projects.

Understanding the Role of an Armature in Stop Motion Animation

What is a Stop Motion Armature?

A stop motion armature is a skeleton-like framework that provides support and articulation to a puppet or figure. It allows for precise positioning and re-positioning frame by frame, enabling smooth, realistic animation sequences. The quality of the armature directly impacts the ease of movement, stability, and overall durability of the animated figure.

Why a Construction Man Armature?

Creating a construction man armature specifically involves designing a sturdy, flexible, and lightweight structure that can withstand repeated movements. The construction man theme often requires specific features like broad shoulders, a helmet, or tool accessories, which add complexity but also authenticity to the final animated figure.

Designing the Construction Man Armature

Planning and Sketching

Before diving into machining, detailed planning is crucial:

- Determine the scale of the figure (e.g., 1:12, 1:6).
- Sketch the construction man, noting joint locations and articulation points.
- Identify specific features like helmet, tool belt, or boots.
- Decide on the range of motion needed for animation sequences.

CAD Modeling

Using computer-aided design (CAD) software helps create precise models:

- Design individual components?bones, joints, connectors.
- Simulate movement to ensure articulation points work smoothly.
- Plan for material thickness and joint tolerances.

Material Selection for Machining the Armature

Common Materials

Choosing the right material is vital for durability and weight:

- **Aluminum:** Lightweight, corrosion-resistant, easy to machine.
- **Steel:** Stronger but heavier; suitable for load-bearing parts.
- **Brass or Bronze:** Good machinability and aesthetic appeal.
- **Stainless Steel:** Durable but requires specialized tools.

Considerations for Material Choice

- Balance between strength and weight.
- Ease of machining and finishing.
- Compatibility with other materials (e.g., joints or connectors).
- Corrosion resistance for longevity.

Machining Techniques for Construction Man Armature

Preparation and Setup

Before machining:

- Secure a clean workspace with proper safety equipment.
- Use precise measuring tools like calipers and micrometers.
- Set up a CNC machine or manual lathe/mill with appropriate fixtures.

Machining the Components

The process generally involves:

- Cutting raw material into manageable blocks.
- Turning operations to shape rounded joints and shafts.
- Milling flat surfaces, slots, or complex geometries.
- Drilling holes for pins or connectors.
- Threading for screws or fasteners if necessary.

Creating Articulating Joints

Articulating joints are critical:

- Machine ball-and-socket joints for shoulders and hips.
- Hinges for elbows and knees.
- Small connectors or pins to allow smooth rotation.

Ensuring Tolerance and Fit

- Maintain tight tolerances for smooth movement without looseness.
- Use reamers or fine files to refine holes and joint surfaces.
- Test-fit components regularly during machining.

Assembly of the Construction Man Armature

Preparing Components

- Clean all machined parts to remove burrs, oils, or debris.
- Apply lubricants if needed to facilitate movement during assembly.

Assembling the Skeleton

- Start with the central spine or torso.
- Attach limbs using pins or threaded connectors.
- Ensure joints move freely but are stable.
- Attach small accessories like helmets or tool belts.

Testing Articulation and Durability

- Manually pose the figure to check range and fluidity.
- Reinforce joints with epoxy or locknuts if necessary.
- Verify that the figure can hold poses for stop motion filming.

Finishing Touches and Enhancements

Surface Finishing

- Sand and polish machined surfaces for smoothness.
- Apply primer or paint if aesthetic appearance matters.
- Consider anodizing aluminum parts for color and corrosion resistance.

Adding Flexibility and Stability

- Incorporate rubber or silicone washers at joints.
- Use high-quality fasteners for secure connections.
- Add padding or foam to areas that contact other parts or surfaces.

Integration with Puppet Features

- Attach flexible armatures to external foam or clay bodies.
- Ensure that external materials do not hinder joint movement.
- Use internal wiring or additional supports for added stability.

Tips for Successful Stop Motion Armature Machining

- Always prioritize safety when operating machining tools?wear protective gear and work in well-ventilated areas.
- Practice on scrap materials to refine your technique.
- Maintain precise measurements throughout all steps.
- Document your design and machining parameters for future reference.
- Test the assembled armature regularly to identify and correct issues early.

Conclusion

Stop motion armature machining a construction man is a meticulous but rewarding process that requires a blend of technical skill and creative vision. By carefully designing, selecting appropriate materials, employing precise machining techniques, and assembling with attention to detail, you can create a durable, articulate, and realistic figure that breathes life into your animation projects. With patience and practice, mastering the art of armature machining elevates your stop motion work and brings your construction man to life with authenticity and finesse.

Stop Motion Armature Machining a Construction Man: An In-Depth Analysis

In the world of stop motion animation, the creation of a realistic, durable, and manipulable armature is paramount. Among various figures and models, constructing a detailed construction man armature stands out as a complex yet rewarding endeavor. This article explores the intricate process of machining a stop motion armature depicting a construction worker, examining the materials, techniques, tools, and craftsmanship involved. Through a comprehensive review, we aim to provide both enthusiasts and professionals with insights into best practices, challenges, and innovative methods in armature fabrication.

Understanding the Role of Armatures in Stop Motion Animation

Before delving into the machining process, it is essential to understand what armatures are and their significance in stop motion filmmaking.

Definition and Function

An armature is a skeleton-like framework that provides structural support to a puppet or figure used in stop motion animation. It allows for stable posing, repeated movements, and durability through numerous shooting sessions.

Key Characteristics of a Good Armature

- Strength and Durability: Able to withstand repeated manipulation without deformation.
- Flexibility: Capable of holding a variety of poses.
- Lightweight: To facilitate ease of handling.
- Range of Motion: Joints and limbs allow natural movement.

The Significance of a Construction Man Theme

A construction man figure embodies industrial strength, utility, and realism. When machining such an armature, the designer aims to reflect these qualities through detailed craftsmanship and precise engineering.

Visual Attributes:

- Hard hats
- Overalls or safety vests
- Tools like hammers or wrenches
- Robust limbs and torso

Functional Attributes:

- Articulated joints mimicking human movement
- Ability to hold various poses
- Compatibility with external accessories or costumes

Material Selection for Construction Man Armature

Choosing appropriate materials is the first critical step in machining a construction-themed armature.

Common Materials Used

- Steel (e.g., steel rods, wire): For strength, rigidity, and longevity.
- Aluminum: Lightweight alternative with good corrosion resistance.
- Brass or Bronze: For joints, providing smooth movement and corrosion resistance.
- Plastic (e.g., ABS or PVC): For non-structural parts or accessories.
- Epoxy or Resin: For finishing or reinforcing joints.

Material Properties to Consider

- Strength-to-weight ratio: Ensuring durability without excessive weight.
- Machinability: Ease of shaping and assembly.
- Corrosion resistance: Especially important if the armature is stored or used in varying environments.
- Compatibility: Materials should bond well with each other and with adhesives.

Designing the Construction Man Armature

An effective design balances realism, functionality, and ease of assembly.

Conceptualization

- Sketch detailed blueprints, emphasizing joint placement, limb proportions, and accessories.
- Incorporate modular parts for easy replacement or adjustments.

Key Design Elements

- Skeleton Frame: Spine, pelvis, limbs, head.
- Joints: Ball-and-socket, hinge, or pivot joints for articulation.
- External Connectors: Mounts for clothing, tools, or accessories.
- Weight Distribution: Ensuring stability during posing.

Machining Techniques for Stop Motion Armature

The machining process involves precise cutting, shaping, and assembly of components.

Tools and Equipment Needed

- Metalworking tools: Lathes, milling machines, drills.
- Hand tools: Files, saws, pliers.
- Welding equipment: For joining metal parts.
- Bending jigs: To shape rods or wires.
- Measurement devices: Calipers, micrometers.

Step-by-Step Machining Process

- Cutting Metal Rods or Wires: To appropriate lengths for limbs and torso.
- Shaping Joints: Using milling machines or drills to create sockets or attachment points.
- Forming Limbs and Body Parts: Bending or machining to match anatomical proportions.
- Assembling the Skeleton: Welding or screwing parts together.
- Creating Articulations: Installing joints with appropriate movement ranges.
- Surface Finishing: Sanding, polishing, or coating to prevent corrosion and improve aesthetics.

Assembly and Detailing

Once the machined parts are ready, assembly involves precise fitting and testing of movement.

Assembly Tips

- Use of lubricants for movable joints.
- Securing joints with set screws, pins, or rivets.
- Ensuring smooth articulation without looseness or excessive friction.

Adding Realism and Functionality

- Attaching miniature tools or safety gear.
- Applying paint or finishes to mimic real construction attire.
- Integrating external accessories for enhanced visual appeal.

Challenges in Machining a Construction Man Armature

Creating a construction-themed armature is fraught with technical and artistic challenges:

- Balancing Strength and Flexibility: Joints must be durable yet allow for natural poses.
- Achieving Anatomical Accuracy: Proportions and joint placement require careful measurement.
- Material Compatibility: Ensuring different metals or plastics bond securely.
- Precision in Machining: Small errors can compromise movement or stability.
- Time-Intensive Process: High levels of detail demand meticulous work.

Innovations and Best Practices

Recent advancements and best practices have improved the quality and efficiency of armature machining:

- Use of CAD Software: For precise design and simulation before machining.
- 3D Printing Components: For complex or intricate parts, especially joint caps or accessories.
- Modular Design Approach: Facilitates repairs or upgrades.
- Surface Treatments: Anodizing or powder coating to enhance corrosion resistance.

Conclusion: The Art and Science of Machining a Construction Man Armature

Machining a stop motion armature depicting a construction man is a meticulous blend of engineering, craftsmanship, and artistic vision. The process demands careful material selection,

precise design, and skilled machining techniques to produce a figure that is both durable and expressive. Whether for professional animation, collectible models, or educational purposes, a well-crafted armature elevates the quality of stop motion projects and provides a tangible connection between technical mastery and creative storytelling.

Through understanding the complexities involved?from initial concept to final assembly?creators can achieve figures that not only serve their functional purpose but also embody the rugged, industrious spirit of construction workers. As technology advances, the integration of digital design and additive manufacturing promises even greater possibilities in armature machining, pushing the boundaries of realism and versatility in stop motion animation.

Question Answer What materials are best for machining a stop motion armature of a construction man? Materials like aluminum, brass, or durable plastics are commonly used for machining stop motion armatures because they offer strength, lightweight properties, and ease of machining. How do I ensure the armature's joints are flexible enough for smooth animation? Incorporate ball joints or flexible pivot points during machining, and consider using small screws or pins to allow rotation while maintaining stability for seamless movement. What tools are recommended for machining detailed features of a construction man armature? Precision CNC mills, micro-drills, rotary tools, and fine files are ideal for achieving detailed features and smooth surfaces on a construction man armature. How do I assemble multiple machined parts of the armature securely? Use threaded rods, set screws, or soldering techniques where appropriate, ensuring tight connections that allow for articulation without compromising stability. What are common challenges faced when machining a construction man armature? Challenges include achieving precise joint tolerances, maintaining lightweight design, avoiding material stress fractures, and ensuring smooth motion during animation. How can I improve the durability of a machined stop motion armature? Choose high-quality, wear-resistant materials and ensure proper finishing and lubrication of joints to reduce wear and extend the armature's lifespan. Is there a recommended scale or size for constructing a construction man armature? The size depends on your project needs, but common scales range from 1/12 to 1/6 for detailed stop motion figures, balancing detail and ease of handling. Are there any safety tips to follow when machining a stop motion armature? Always wear protective gear, work in well-ventilated areas, handle tools carefully, and follow manufacturer instructions to prevent injuries during machining.

Related keywords: stop motion armature, armature machining, construction man figure, stop motion animation, puppet armature, model making, character sculpture, figure fabrication, animation puppet, armature design

Motion physics full topic

Motion physics full topic explores the fundamental principles that govern the movement of objects in our universe. As a core branch of physics, it provides insights into how objects move, interact, and respond to forces. Understanding motion physics is essential for various scientific and engineering applications, from designing vehicles to analyzing celestial phenomena. This comprehensive guide covers all essential aspects of motion physics, offering a detailed overview suitable for students, educators, and enthusiasts alike.

Introduction to Motion Physics

Motion physics, also known as kinematics and dynamics, studies the behavior of objects in motion and the forces that influence them. It explains how objects change position over time and the factors affecting these changes. The study of motion is foundational to understanding the physical universe and forms the basis for more advanced topics like electromagnetism and thermodynamics.

Types of Motion

Motion can be classified into various types based on the nature of movement:

1. Uniform Motion

- Occurs when an object moves with a constant velocity.
- The object covers equal distances in equal intervals of time.
- Characterized by a straight-line path with no acceleration.

2. Non-uniform Motion

- The velocity of the object changes over time.
- Involves acceleration or deceleration.
- Can be along a straight line or a curved path.

3. Circular Motion

- Movement along a circular path.
- Can be uniform (constant speed) or non-uniform.
- Examples include a car turning on a curved road or a satellite orbiting Earth.

4. Periodic Motion

- Motion that repeats itself after regular intervals.
- Examples include pendulum swings and vibrating guitar strings.

Basic Concepts and Definitions

Understanding motion physics requires familiarity with several fundamental concepts:

- **Displacement:** The change in position of an object from its initial point to its final point.
- **Distance:** The total length of the path traveled by the object.
- **Speed:** The rate at which an object covers distance, calculated as distance divided by time.
- **Velocity:** The rate of change of displacement, including direction.
- **Acceleration:** The rate at which velocity changes over time.

Kinematics: Describing Motion

Kinematics focuses on describing motion without considering forces. It involves analyzing displacement, velocity, and acceleration.

Equations of Motion

For uniformly accelerated motion, the following equations are fundamental:

- $v = u + at$
- $s = ut + \frac{1}{2} at^2$
- $v^2 = u^2 + 2as$

where:

- u = initial velocity
- v = final velocity
- a = acceleration
- s = displacement
- t = time

Graphical Representation

Graphs are powerful tools in analyzing motion:

- **Displacement-Time Graph:** Shows how displacement varies over time.
- **Velocity-Time Graph:** Indicates acceleration through the slope of the graph.
- **Acceleration-Time Graph:** Shows how acceleration varies with time.

Dynamics: Forces and Motion

While kinematics describes motion, dynamics explains why objects move. It involves analyzing forces acting on objects and their effects.

Newton's Laws of Motion

The foundation of dynamics is Newton's three laws:

- **First Law (Law of Inertia):** An object remains at rest or in uniform motion unless acted upon by an external force.
- **Second Law:** The force acting on an object is equal to the mass times acceleration ($F = ma$).
- **Third Law:** For every action, there is an equal and opposite reaction.

Types of Forces

Understanding forces is crucial in motion physics:

- **Gravitational Force:** Attractive force between masses.
- **Frictional Force:** Resistance force opposing motion.
- **Normal Force:** Perpendicular force exerted by a surface.
- **Applied Force:** Force applied by an external agent.
- **Air Resistance:** Frictional force exerted by air on moving objects.

Types of Motion in Detail

Exploring specific types of motion provides deeper insights.

Linear Motion

- Movement along a straight line.
- Described by the equations of motion for uniform or accelerated motion.
- Examples include a car moving on a straight road.

Projectile Motion

- Motion of an object projected into the air under gravity.
- Combines horizontal motion with vertical free fall.
- Key parameters include launch angle, initial velocity, and acceleration due to gravity.
- Equations govern the range, maximum height, and time of flight.

Rotational Motion

- Motion of objects rotating about an axis.
- Characterized by angular displacement, angular velocity, and angular acceleration.
- Moment of inertia and torque are critical concepts.
- Applications include spinning wheels and planetary rotations.

Units and Measurement in Motion Physics

Accurate measurement is fundamental in studying motion:

- **Length/Distance:** meters (m)
- **Time:** seconds (s)
- **Velocity/Speed:** meters per second (m/s)
- **Acceleration:** meters per second squared (m/s^2)
- **Force:** Newtons (N)

Real-World Applications of Motion Physics

Understanding motion physics has numerous practical applications:

- Designing safer vehicles with better understanding of acceleration and braking distances.
- Analyzing projectile trajectories in sports and military applications.
- Developing space exploration technology, including rocket launches and satellite orbits.
- Creating more efficient machinery and robotics.
- Understanding biological movements in biomechanics.

Advanced Topics in Motion Physics

Beyond basic concepts, advanced topics include:

Relativistic Motion

- Describes motion at speeds close to the speed of light.
- Incorporates Einstein's theory of relativity.

Nonlinear Dynamics and Chaos

- Studies complex systems where small changes can lead to unpredictable behavior.

Conclusion

Motion physics is a comprehensive field that explains how objects move and interact within the physical universe. From simple linear motion to complex rotational and projectile movements, the principles of motion are integral to understanding the natural world. Mastery of these concepts enables scientists and engineers to innovate and solve real-world problems effectively. Whether analyzing the trajectory of a ball or designing the next generation of spacecraft, the study of motion physics remains a cornerstone of scientific inquiry and technological advancement.

Motion Physics: Unlocking the Secrets of Movement in the Universe

In the realm of physics, understanding motion is fundamental to unraveling the intricate tapestry of how objects move within our universe. Motion physics, a cornerstone of classical physics, provides the frameworks and laws that describe why objects move the way they do—be it a planet orbiting a star, a car accelerating on a highway, or particles dancing within atomic nuclei. This comprehensive exploration aims to dissect the topic of motion physics in detail, presenting it as an essential guide for students, educators, and enthusiasts eager to grasp the core principles governing movement.

Introduction to Motion Physics

Motion physics, often referred to as kinematics and dynamics, is the branch of physics concerned with describing and understanding the behavior of objects in motion. It encompasses the study of how objects move, why they move, and the forces influencing their motion. From the earliest observations of celestial bodies to modern-day engineering, motion physics forms the backbone of numerous scientific and technological advancements.

Fundamental Concepts in Motion Physics

A robust understanding of motion physics begins with grasping its fundamental concepts. These core ideas serve as the building blocks for analyzing any movement phenomenon.

Distance and Displacement

- Distance: The total length of the path traveled by an object, regardless of direction. It is a scalar quantity, meaning it has magnitude only.
- Displacement: The shortest straight-line distance from the initial to the final position of an object, along with its direction. Displacement is a vector quantity, possessing both magnitude and direction.

Example: If a person walks 5 meters east, then 3 meters west, their total distance traveled is 8 meters, but their displacement is 2 meters east.

Speed and Velocity

- Speed: The rate at which an object covers distance, calculated as distance divided by time. It is scalar.

\[

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

\]

- Velocity: The rate at which an object changes its position, considering both speed and direction. It is a vector quantity.

\[

$$\text{Velocity} = \frac{\text{Displacement}}{\text{Time}}$$

\]

Example: A car traveling at 60 km/h east has a velocity of 60 km/h east.

Acceleration

Acceleration describes how an object's velocity changes over time. It can be positive (speeding up), negative (slowing down), or change in direction.

\[

$$a = \frac{\Delta v}{\Delta t}$$

\]

where Δv is the change in velocity and Δt is the time interval.

Types of acceleration:

- Uniform acceleration: constant rate of change.
- Non-uniform acceleration: variable rate of change.

Kinematics: Describing Motion

Kinematics provides the mathematical descriptions of motion without considering the causes (forces). It employs equations that relate displacement, velocity, acceleration, and time.

Equations of Uniform Acceleration

For objects experiencing constant acceleration, the following equations are fundamental:

- Final velocity:

\[

$$v = u + at$$

\]

where:

- v = final velocity
- u = initial velocity
- a = acceleration
- t = time

- Displacement:

$\backslash$

$$s = ut + \frac{1}{2}at^2$$

 $\backslash$

- Velocity squared:

 $\backslash$

$$v^2 = u^2 + 2as$$

 $\backslash$

Application: These equations help analyze free-fall motion, vehicle acceleration, and projectile motion.

Dynamics: The Causes of Motion

While kinematics describes how objects move, dynamics explains why they move by examining the forces involved.

Newton's Laws of Motion

Sir Isaac Newton revolutionized physics with three fundamental laws:

- First Law (Inertia):

An object remains at rest or in uniform motion unless acted upon by an external force.

- Second Law:

The acceleration of an object is directly proportional to the net force acting on it and inversely proportional to its mass:

 $\backslash$

$$F = ma$$

\]

- Third Law:

For every action, there is an equal and opposite reaction.

Implication: These laws underpin all classical motion analyses, connecting forces to resulting motion.

Types of Forces Influencing Motion

- Contact Forces: Friction, tension, normal force, applied force.
- Non-contact Forces: Gravitational, electromagnetic, nuclear forces.

Friction: Acts opposite to motion, affecting objects moving on surfaces or through fluids.

Gravity: A universal attractive force, crucial in planetary motion and free-fall scenarios.

Types of Motion

Motion can be categorized based on the nature of the movement:

Linear Motion

- Motion along a straight line.
- Can be uniform or uniformly accelerated.
- Examples: car moving along a straight highway, free-fall.

Angular Motion

- Motion about an axis.
- Described by angular displacement, velocity, and acceleration.
- Examples: spinning wheel, planetary orbits.

Projectile Motion

- Combines horizontal and vertical motion under gravity.
- Path traced is a parabola.
- Key variables: initial velocity, launch angle, acceleration due to gravity.

Oscillatory Motion

- Repetitive back-and-forth movement.
- Examples: pendulums, springs.

Advanced Topics in Motion Physics

For those seeking deeper insight, motion physics extends into more complex areas:

Relative Motion

- Describes the motion of an object as observed from different frames of reference.
- Essential in understanding how motion appears differently to observers in different states of motion.

Non-Uniform Circular Motion

- Motion along a circular path with changing speed.
- Requires concepts of centripetal acceleration and force.

Relativity and High-Speed Motion

- At velocities approaching the speed of light, classical mechanics give way to Einstein's theory of relativity, altering our understanding of motion.

Applications of Motion Physics

Understanding motion physics is not just academic; it has wide-ranging practical applications:

- Engineering: Designing vehicles, machinery, and robotics.
- Aerospace: Calculating trajectories and orbits.
- Sports Science: Improving athletic performance through motion analysis.

- Medicine: Understanding biomechanics and movement disorders.
- Astronomy: Explaining planetary and stellar motion.

Conclusion: The Significance of Motion Physics

Motion physics is undeniably a cornerstone of our understanding of the physical universe. Its principles underpin everything from the microscopic interactions within atoms to the grand celestial dances of planets and stars. Whether analyzing the trajectory of a baseball, designing safer automobiles, or exploring the cosmos, the laws and concepts of motion physics are indispensable tools.

By mastering the core ideas of kinematics and dynamics, learners unlock a powerful lens through which to interpret the natural world, fostering innovations and deepening our appreciation of the universe's elegant choreography. As science advances, the foundations laid by classical motion physics continue to guide us towards new frontiers of discovery, highlighting its enduring relevance and vital importance.

In summary, motion physics combines fundamental concepts, mathematical descriptions, and force interactions to provide a comprehensive understanding of how objects move. Its study not only satisfies intellectual curiosity but also propels technological progress and enhances our daily lives. Whether you are a student, educator, or enthusiast, delving into motion physics offers a rewarding journey through the mechanics that govern our universe.

QuestionAnswer What is the difference between speed and velocity in motion physics? Speed is a scalar quantity that measures how fast an object is moving regardless of direction, while velocity is a vector quantity that includes both speed and direction of motion. What are Newton's three laws of motion? Newton's three laws are: 1) An object remains at rest or in uniform motion unless acted upon by an external force. 2) The force acting on an object equals its mass times acceleration ($F=ma$). 3) For every action, there is an equal and opposite reaction. How is acceleration different from velocity? Velocity describes the rate of change of position with direction, whereas acceleration describes the rate of change of velocity with respect to time. What is the concept of projectile motion? Projectile motion refers to the motion of an object projected into the air, subject to gravity, following a curved trajectory. It involves horizontal and vertical components of motion that can be analyzed separately. What is the principle of conservation of momentum? The principle states that in a closed system with no external forces, the total momentum before an interaction equals the total momentum after the interaction. How do you calculate average velocity? Average velocity is calculated by dividing the total displacement by the total time taken, given by the formula: $v_{avg} = \frac{\Delta x}{\Delta t}$. What are the different types of motion studied in physics? The main types include uniform motion (constant velocity), non-uniform motion (changing velocity), accelerated motion, circular motion, and oscillatory motion.

Related keywords: kinematics, dynamics, Newton's laws, velocity, acceleration, force, momentum, energy, work, rotational motion

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