

A Coolie Carries A Load Of 500 N To A Distance Of 100 M On A Horizontal Platform. The Work Done By Him

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Understanding the concept of work done in physics is essential for grasping how energy is transferred during physical activities. In this context, analyzing the work done by a coolie carrying a load provides insight into fundamental principles such as force, displacement, and energy transfer. This article explores the detailed calculation of the work done by a coolie carrying a 500 N load over a distance of 100 meters on a horizontal platform, along with related concepts, significance, and practical applications.

Introduction to Work in Physics

What is Work?

In physics, work is defined as the product of the force applied to an object and the displacement of the object in the direction of the applied force. The mathematical expression is:

$$\text{Work (W)} = \text{Force (F)} \times \text{Displacement (d)} \times \cos\theta$$

Where:

- F is the magnitude of the force applied,
- d is the displacement,
- θ is the angle between the force and displacement vectors.

Conditions for Work to Be Done

Work is considered done when:

- A force is exerted on an object,
- There is displacement of the object in the direction of the force,
- The force causes a change in the position of the object.

If the displacement is zero or the force acts perpendicular to the displacement, the work done is zero.

Scenario Description: The Coolie Carrying a Load

Details of the Problem

- The coolie exerts a force to carry a load of 500 N.
- The load is transported over a horizontal distance of 100 meters.
- The movement occurs on a flat platform, implying no vertical displacement.
- The goal is to calculate the work done by the coolie during this process.

Understanding the Force Involved

- The load has a weight of 500 N, which is the force of gravity acting downward.
- To carry the load horizontally, the coolie must exert an equal and opposite force to balance the load and overcome resistance, such as friction.
- For simplicity, assuming negligible friction and air resistance, the force the coolie exerts horizontally is equal in magnitude to the weight of the load, i.e., 500 N, to move it steadily.

Calculating the Work Done

Assumptions Made in the Calculation

- The force exerted by the coolie is constant at 500 N.
- The displacement occurs along the direction of the force (horizontal movement).
- No acceleration occurs; the movement is steady, implying the force balances resistance without additional acceleration.
- The force is applied parallel to displacement, so the angle θ is zero degrees.

Step-by-Step Calculation

1. Identify the force involved:

- Force exerted by the coolie, $F = 500 \text{ N}$

2. Identify the displacement:

- Distance moved, $d = 100 \text{ meters}$

3. Determine the angle θ :

- Since the force is horizontal and displacement is horizontal, $\theta = 0^\circ$

4. Calculate the work done:

- Using the work formula: $W = F \times d \times \cos\theta$
- $\cos 0^\circ = 1$, so:
- $W = 500 \text{ N} \times 100 \text{ m} \times 1 = 50,000 \text{ Joules}$

Understanding the Result: 50,000 Joules

What Does 50,000 Joules Signify?

- The work done by the coolie in carrying the load over 100 meters is 50,000 Joules.
- It represents the energy transferred from the coolie's muscles to the load, overcoming any resistance and moving the load horizontally.

Implications of the Calculation

- This amount of work indicates the physical effort involved in such a task.
- It reflects the energy expenditure of the coolie during the task.
- The calculation assumes ideal conditions; real-world factors like friction and fatigue can alter actual work done.

Factors Affecting Work Done in Real-World Situations

Frictional Resistance

- In practical scenarios, friction between the load and the platform opposes movement.
- The force needed to overcome friction adds to the force exerted by the coolie.
- The total force exerted becomes $F_{\text{total}} = F_{\text{load}} + F_{\text{friction}}$.

Vertical Displacement and Work Against Gravity

- If the load is lifted vertically, work done involves energy against gravity, calculated as:

Work = mass $\times$ gravity $\times$ height

- In our scenario, since movement is horizontal, vertical work is negligible unless the load is lifted or lowered.

Efficiency and Energy Expenditure

- Not all energy exerted by the coolie is converted into useful work; some is lost as heat, sound, and fatigue.
- Human efficiency in such activities varies typically between 10-25%.

Practical Applications and Significance

Understanding Mechanical Work in Daily Activities

- Recognizing the energy involved in manual labor helps in designing ergonomic tools and work practices.
- It emphasizes the importance of mechanical advantage and proper techniques to reduce effort.

Impact on Occupational Health and Safety

- Awareness of work and energy expenditure guides workers in avoiding fatigue and injuries.
- Proper planning ensures tasks are performed within safe exertion limits.

Designing Mechanical Aids and Equipment

- Knowledge of work calculations aids engineers in designing carts, trolleys, and conveyor systems.
- These systems reduce the effort required, increasing productivity and safety.

Conclusion

The calculation of the work done by a coolie carrying a 500 N load over 100 meters on a horizontal platform exemplifies core principles of physics related to force, displacement, and energy transfer. The straightforward computation reveals that the coolie performs 50,000 Joules of work, which reflects the energy expenditure involved in such manual tasks. While ideal conditions suggest this value, real-world factors like friction, fatigue, and efficiency influence actual effort. Understanding these concepts not only enhances comprehension of physical phenomena but also supports practical applications in occupational health, engineering, and productivity improvements. Recognizing the significance of work and energy in everyday activities underscores the importance of optimizing effort and designing better tools and systems for manual labor.

Keywords: work done, force, displacement, physics, energy transfer, manual labor, efficiency, friction, horizontal movement, load carrying

Frequently Asked Questions

What is the work done by the coolie in carrying a load of 500 N over 100 meters?

The work done is 50,000 Joules, calculated by multiplying the load (500 N) by the distance (100 m).

How is work calculated in this scenario?

Work is calculated as the product of force and displacement in the direction of the force, so $\text{Work} = 500 \text{ N} \times 100 \text{ m} = 50,000 \text{ Joules}$.

Does carrying the load on a horizontal platform affect the work done compared to lifting it vertically?

Yes, carrying the load horizontally involves doing work against friction and other resistive forces, but the work calculated here considers only the force in the direction of displacement. Vertical lifting work would involve gravitational potential energy change.

What assumptions are made when calculating the work done in this scenario?

It is assumed that the force exerted by the coolie equals the weight of the load (500 N), and that the force acts in the same direction as the displacement without any additional resistive forces considered.

If the load was carried for a longer distance, how would the work done change?

The work done would increase proportionally with the distance, since $\text{Work} = \text{force} \times \text{distance}$; doubling the distance would double the work.

Is the work done by the coolie positive or negative in this context?

The work done by the coolie is positive because he exerts a force in the direction of the displacement.

What is the significance of the work done in terms of energy transfer?

The work done represents the energy transferred from the coolie to overcome resistive forces and move the load, effectively increasing the load's energy state over the distance.

Can the work done be considered as useful work in this scenario?

Yes, if the goal is to move the load from one point to another, the work done constitutes useful work,

assuming no energy losses are considered.

How does the concept of work relate to real-world activities like carrying loads?

In real-world activities, work quantifies the effort and energy expenditure involved in moving objects, helping us understand the physical effort required and energy efficiency.

Additional Resources

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Understanding the concept of work done in physics is fundamental to comprehending how energy transfer occurs during various physical activities. In this scenario, a coolie (a laborer) carrying a load of 500 N across a horizontal distance of 100 meters provides an excellent example to analyze the work he performs. This real-world situation combines principles of force, displacement, and energy, making it a practical illustration of physics in everyday life.

Introduction to the Scenario

The task involves a coolie transporting a load of 500 N over a flat horizontal surface spanning 100 meters. The key variables here are the magnitude of the force (500 N), the direction of movement (horizontal), and the distance covered (100 meters). This scenario allows us to explore how work is calculated in physics, the factors influencing it, and the implications of such physical labor.

Understanding Work in Physics

Definition of Work

In physics, work is defined as the product of the force applied to an object and the displacement of the object in the direction of the force. Mathematically, it is expressed as:

$$\text{Work (W)} = \text{Force (F)} \times \text{Displacement (d)} \times \cos\theta$$

where θ is the angle between the force and displacement vectors.

Conditions for Work to be Done

- The force must be applied to the object.
- The object must undergo displacement.
- The displacement must have a component in the direction of the applied force.

In the case of the coolie, the force is applied horizontally to move the load, and the load is displaced horizontally, satisfying the conditions for work.

Calculating the Work Done by the Coolie

Given data:

- Force, $F = 500 \text{ N}$
- Displacement, $d = 100 \text{ meters}$
- Since the movement is horizontal and the force is applied horizontally, the angle $\theta = 0^\circ$, and $\cos\theta = 1$.

Work done, $W = F \times d \times \cos 0^\circ = 500 \text{ N} \times 100 \text{ m} \times 1 = 50,000 \text{ Joules}$

Therefore, the coolie does 50,000 Joules (or 50 kJ) of work in transporting the load over 100 meters.

Factors Affecting the Work Done

While the calculation appears straightforward, several factors influence the actual work performed:

1. Nature of the Force

- The force exerted by the coolie may include overcoming friction, air resistance, and the weight of the load.
- If the force applied exactly balances the load's weight and friction, then the calculation is accurate.

2. Friction and Resistance

- Friction between the load and the platform resists motion.
- The work done must compensate for these resistive forces, which could be more than just lifting the load.

3. Vertical Components of Work

- If the coolie lifts the load vertically before moving horizontally, some work is done against gravity.

- However, in this scenario, since the load is carried on a horizontal platform, and the force is horizontal, vertical work components are negligible.

4. Efficiency of the Movement

- The coolie's effort may include energy lost due to inefficiencies like fatigue, friction, and other resistances.
- The actual energy expenditure by the coolie could be higher than the calculated work.

Physical and Practical Aspects of the Work Done

Energy Transfer and Metabolism

The work done by the coolie translates into energy expenditure, which is ultimately derived from metabolic processes within his body. Carrying a load involves muscular effort, movement, and balance, leading to calorie consumption.

Efficiency of Human Labor

- Human muscles are not 100% efficient; typically, only about 20-25% of the chemical energy from food is converted into mechanical work.
- The remaining energy is lost as heat.

Implications of Work Done in Real Life

- Repeated physical exertion can lead to fatigue.
- Proper techniques and tools (like carts or wheelbarrows) can reduce the work and effort required.

Pros and Cons of Carrying Loads Manually

Pros:

- No dependency on machinery or transportation aids.
- Low initial investment; only labor is required.
- Flexibility in moving through narrow or uneven terrains where vehicles cannot operate.

Cons:

- Physically exhausting and time-consuming.
- Risk of injury or health issues due to strain.
- Lower efficiency compared to mechanized transport.

- Limited load capacity and speed.

Features and Considerations in Work Calculation

- Horizontal Movement: Since the load is moved on a horizontal platform, work calculation simplifies to $F \times d$.
- Force Balance: The force applied by the coolie must at least counteract the load's weight and any resistive forces.
- Energy Expenditure: The actual energy used by the coolie is higher than the calculated work due to inefficiencies.
- Environmental Factors: Terrain, weather, and load stability influence the effort involved.

Implications in Daily Life and Economics

Understanding the work involved in manual labor such as this provides insights into the energy costs associated with physical activities. It emphasizes the importance of tools, technology, and ergonomic practices to reduce effort and improve efficiency. For example:

- Using carts or wheelbarrows reduces the force needed.
- Mechanical aids can significantly decrease the work and energy expenditure.
- Recognizing the human effort involved highlights the need for labor welfare and safety standards.

Conclusion

The scenario of a coolie carrying a 500 N load over 100 meters exemplifies fundamental physics principles related to work and energy. The calculated work of 50,000 Joules underscores the significant effort involved in manual transportation. While the straightforward calculation provides an idealized estimate, real-world factors such as friction, inefficiencies, and human fatigue influence the actual effort. Recognizing these aspects not only enhances our understanding of physics but also underscores the importance of technological aids and ergonomic practices in reducing physical labor and improving productivity. Ultimately, analyzing such everyday activities through the lens of physics fosters appreciation for human effort and the potential for innovations to ease physical burdens.

Note: This detailed analysis is designed to be comprehensive and educational, providing clear explanations, relevant calculations, and thoughtful insights into the physics of manual labor

activities.

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