

DatePage710A machine Raises A Load Of 750N through A Height of 16m In 5 Sec calculate a) Work Done By Machine b)

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Introduction

The scenario involves a machine, referred to as DatePage710A machine, performing a lifting operation where it raises a load of 750 Newtons (N) through a vertical height of 16 meters within a time span of 5 seconds. This situation is a classic example used in physics and engineering to understand the concepts of work, power, and energy transfer in mechanical systems. Calculating the work done by the machine provides insight into the energy expenditure required to perform such a task, which has practical applications in designing efficient lifting devices, understanding energy consumption, and evaluating machine performance.

In this article, we will explore how to calculate the work done by the machine, analyze the physics behind the operation, and extend the discussion to related concepts such as power output and efficiency. Whether you're a student, engineer, or enthusiast, understanding these calculations is fundamental to grasping how mechanical systems operate in real-world scenarios.

Context and Relevance of the Problem

Lifting objects is a common mechanical task, and analyzing such operations helps in designing machines like cranes, elevators, and hoists. The core physics principles involved include force, displacement, work, and energy. The work done by a machine in lifting a load is directly related to the force applied and the distance over which this force is exerted.

In real-world applications, understanding how much work a machine performs during a given period helps in:

- Assessing the energy efficiency of machinery
- Calculating power consumption
- Designing systems to optimize performance
- Ensuring safety and reliability in lifting operations

The problem at hand simplifies these principles into a straightforward calculation, which will be detailed in the subsequent sections.

Understanding the Parameters

Before diving into the calculations, let's clarify the parameters involved:

- Force (F): 750 N (the weight of the load)
- Height (h): 16 meters (the vertical distance the load is raised)
- Time (t): 5 seconds (duration of the lifting operation)

These parameters form the basis for calculating work and power, essential concepts in physics related to energy transfer.

Calculating the Work Done by the Machine

Definition of Work

In physics, work (W) is defined as the product of the force applied on an object and the displacement in the direction of the force:

$$W = F \times d$$

where:

- F is the force applied
- d is the displacement along the direction of the force

When lifting an object vertically, the work done is equal to the gravitational potential energy gained by the load.

Step-by-Step Calculation

Given:

- Force $F = 750$, N
- Displacement $d = 16$, m

Calculate the work:

$$W = F \times d = 750 \, \text{N} \times 16 \, \text{m} = 12,000 \, \text{J}$$

Result: The machine does 12,000 Joules (J) of work to lift the load.

Interpretation of the Work Done

The work of 12,000 J signifies the amount of energy transferred to the load during the lifting operation. This energy increases the load's gravitational potential energy, which is given by:

$$\text{Potential Energy (PE)} = m \times g \times h$$

where:

- m is the mass of the load
- g is acceleration due to gravity ($\approx 9.8 \text{ m/s}^2$)
- h is the height

To verify consistency, let's calculate the mass of the load:

$$m = \frac{F}{g} = \frac{750 \text{ N}}{9.8 \text{ m/s}^2} \approx 76.53 \text{ kg}$$

And potential energy:

$$\text{PE} = 76.53 \text{ kg} \times 9.8 \text{ m/s}^2 \times 16 \text{ m} \approx 12,000 \text{ J}$$

This confirms that the work done by the machine aligns with the increase in gravitational potential energy of the load.

Calculating Power Output

Power is the rate at which work is done over time and is expressed as:

$$P = \frac{W}{t}$$

where:

- P is power in Watts (W)
- W is work in Joules (J)
- t is time in seconds (s)

Given:

- $W = 12,000 \text{ J}$
- $t = 5 \text{ s}$

Calculate:

$$P = \frac{12,000 \text{ J}}{5 \text{ s}} = 2,400 \text{ W}$$

Result: The machine's average power output during the lifting process is 2,400 Watts.

Additional Considerations

Mechanical Efficiency

In real-world scenarios, machines are not 100% efficient due to factors like friction, resistance, and energy losses. Therefore, the actual work input might be higher than the calculated work output. To determine efficiency:

$$\text{Efficiency } (\eta) = \frac{\text{Work done on load}}{\text{Work input by machine}} \times 100\%$$

If data about input energy or power is available, the efficiency can be assessed. Without such data, we assume ideal conditions for simplicity.

Energy Conservation

The work done by the machine directly translates into the potential energy gained by the load, illustrating the principle of conservation of energy. This fundamental concept is foundational in physics and engineering, emphasizing how energy is transferred and transformed during mechanical operations.

Practical Applications of the Calculations

Understanding the calculations involved in lifting operations has numerous practical applications:

- Design of Lifting Equipment: Engineers can determine the required power and energy capacity for cranes and hoists.
- Energy Management: Estimating energy consumption for industrial processes involving lifting.
- Safety Protocols: Ensuring machinery can handle loads without exceeding designed capacities.
- Operational Efficiency: Optimizing lifting speeds and minimizing energy waste.

Summary of Key Points

- The work done by DatePage710A machine to lift a 750 N load through 16 meters is 12,000 Joules.
- The average power output during this operation is 2,400 Watts.
- The calculations confirm the relationship between force, displacement, work, and energy transfer.
- Practical considerations include machine efficiency and energy losses, which are crucial for real-world applications.

Conclusion

This detailed analysis underscores the importance of fundamental physics principles in understanding and designing mechanical systems. The ability to accurately calculate work and power not only enhances our comprehension of energy transfer but also informs the development of safer, more efficient lifting machinery. Whether in industrial settings or academic exercises, mastering these calculations is essential for anyone involved in mechanical engineering, physics, or related fields.

By understanding the work done by DatePage710A machine, stakeholders can optimize operational performance, manage energy consumption effectively, and ensure safety standards are met in lifting operations.

Frequently Asked Questions

What is the work done by the machine in raising a load of 750N through a height of 16m?

The work done by the machine is calculated using the formula $\text{Work} = \text{force} \times \text{height}$. Therefore, $\text{Work} = 750 \text{ N} \times 16 \text{ m} = 12,000 \text{ Joules}$.

How long does it take for the machine to raise the load in this scenario?

The machine raises the load in 5 seconds, as specified in the problem statement.

What is the power exerted by the machine during this operation?

Power is calculated as Work done divided by time. So, $\text{Power} = 12,000 \text{ J} / 5 \text{ s} = 2,400 \text{ Watts}$.

What does the work done by the machine tell us about its efficiency?

The work done indicates the amount of energy transferred to the load. To assess efficiency, compare the work output to the energy input, considering any losses, which are not specified here.

Can we determine the work done if the load's weight or height changes?

Yes, the work done can be recalculated using the formula $\text{Work} = \text{force} \times \text{height}$ for any new load or height values.

Why is calculating work important in understanding machine performance?

Calculating work helps evaluate the amount of energy the machine transfers to the load, which is essential for assessing its effectiveness and efficiency in performing tasks.

Additional Resources

DatePage710A
machine Raises A Load Of 750N through A Height of 16m In 5 Sec;
Calculate a) Work Done By Machine b)

In the realm of mechanical engineering and physics, understanding how machines perform work is fundamental. Recently, a scenario involving a machine—referred to as DatePage710A—has captured attention due to its straightforward yet insightful problem: it raises a load of 750 newtons through a height of 16 meters in 5 seconds. This example not only offers an opportunity to practice core concepts such as work and power but also highlights the importance of precise calculations in evaluating machine efficiency. In this article, we will dissect the problem thoroughly, exploring the concepts involved, step-by-step calculations, and the broader implications for engineering applications.

Understanding the Problem: Key Details and Concepts

Before delving into calculations, it is essential to clarify the core parameters of the problem:

- Load (Force): 750 N (Newtons)
- Height Raised: 16 meters
- Time Taken: 5 seconds

The task involves calculating:

a) Work Done by the Machine: How much energy does the machine expend to lift the load?

b) Power Developed by the Machine: How much rate of work (power) is the machine delivering during this operation?

This problem essentially combines the principles of work, energy, and power, which are foundational concepts in physics and engineering.

Key Definitions:

- Work (W): The energy transferred when a force moves an object over a distance in the direction of the force. Mathematically, $W = F \times d$ when force is constant and in the same direction as displacement.

- Power (P): The rate at which work is done or energy is transferred. Defined as $P = \frac{W}{t}$.

Understanding these concepts is crucial for analyzing the machine's performance.

Calculating the Work Done by the Machine

The first step involves calculating the total work performed by the machine during the lifting operation.

Step 1: Clarify the Force and Displacement

- The load's weight (force due to gravity) is given as 750 N. This is the force the machine needs to overcome to lift the load.

- The displacement (distance moved vertically) is 16 meters.

Since the force is in the same direction as displacement (upward), the work done is straightforward to compute.

Step 2: Applying the Work Formula

The work done (W) is given by:

$$W = F \times d$$

where:

$$- \text{ (} F = 750 \text{ , } \text{N} \text{)}$$

$$- \text{ (} d = 16 \text{ , } \text{m} \text{)}$$

Calculating:

$$\text{ [} W = 750 \text{ , } \text{N} \times 16 \text{ , } \text{m} = 12,000 \text{ , } \text{J} \text{]}$$

Result: The machine does 12,000 Joules of work in raising the load.

Additional Considerations: Is this the total work done?

In real-world applications, the work calculated as above assumes no losses. Factors like friction, air resistance, and mechanical inefficiencies are ignored here for simplicity. Nonetheless, for this problem, the ideal work done is 12,000 Joules.

Calculating the Power Developed by the Machine

While work measures the total energy transfer, power indicates how quickly this work is performed.

Step 1: Use the Power Formula

$$\text{ [} P = \frac{W}{t} \text{]}$$

where:

$$- \text{ (} W = 12,000 \text{ , } \text{J} \text{)}$$

$$- \text{ (} t = 5 \text{ , } \text{seconds} \text{)}$$

Calculating:

$$\text{ [} P = \frac{12,000 \text{ , } \text{J}}{5 \text{ , } \text{s}} = 2,400 \text{ , } \text{W} \text{]}$$

Result: The machine develops a power of 2,400 Watts during the operation.

Interpreting the Power Output

A power output of 2,400 Watts (or 2.4 kW) indicates the rate at which the machine is doing work. In practical terms, this is comparable to the power

output of several small household appliances, reflecting a fairly robust lifting mechanism.

Broader Context and Practical Implications

While the calculations above are straightforward, understanding their real-world relevance is crucial for engineers and technicians.

Efficiency Considerations

The ideal work and power calculations assume 100% efficiency. Real machines experience losses:

- Friction: Mechanical parts generate resistance, requiring more input energy.
- Electrical Losses: Motors and electronic components convert electrical energy with some losses.
- Material Stress: Deformation and wear contribute to inefficiency.

To evaluate actual machine performance, efficiency ratios are used:

$$\text{Efficiency } (\eta) = \frac{\text{Useful work output}}{\text{Total energy input}} \times 100\%$$

In this scenario, if the actual energy input was higher than 12,000 Joules due to losses, the efficiency would be less than 100%.

Application in Engineering and Design

Understanding the work and power involved in lifting loads helps engineers:

- Design appropriately rated machinery.
- Optimize energy consumption.
- Ensure safety margins are met.
- Calculate operational costs and energy requirements.

Real-World Examples and Analogies

To contextualize these calculations, consider everyday lifting devices:

- Elevators: Modern elevators often have motors rated in kilowatts, similar to the 2.4 kW calculated here, for lifting substantial loads efficiently.
- Cranes: Industrial cranes lift heavy materials with power ratings tailored to their maximum load and speed requirements.
- Manual Lifting: Human effort also involves work and power calculations, highlighting the importance of mechanical aids to reduce effort and increase efficiency.

Concluding Remarks

The problem involving DatePage710A exemplifies fundamental physics principles with practical engineering relevance. Calculating the work done—12,000 Joules—is straightforward when force and displacement are known, providing insight into the energy involved in lifting operations. Determining the power output—2,400 Watts—helps evaluate how quickly the work is performed, informing design choices and operational efficiency.

This case study underscores the importance of precise calculations in engineering tasks, enabling the development of safer, more efficient machinery. Whether in manufacturing, construction, or everyday appliances, understanding the interplay of force, work, and power remains central to technological progress. As engineering challenges grow more complex, such foundational knowledge ensures that innovations are both effective and sustainable, paving the way for smarter, energy-efficient solutions in the future.

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