

Work and Power – GCSE Physics

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1. Introduction

- **Work** and **Power** are fundamental concepts in physics that describe how forces affect motion and energy transfer.
- Understanding these concepts is essential in physics and engineering that help us understand and quantify energy transfer, efficiency, and mechanical performance in real-world applications.

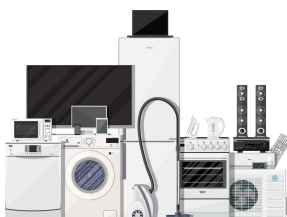
Real-Life Applications of Work and Power:



Transportation



Sports & Fitness



Technology



Energy Production

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2. What is Work and how is it measure?

- **Work** is done when a force causes an object to move in the direction of the force.
- It is defined as the product of force and the distance moved by an object in the direction of the force.
- It is a **Scalar Quantity**.
- The SI unit of work is the joule (**J**).
- **Work** can be measured using the formula:

$$E = F \times d$$

Where,

- **E** = Work done
- **F** = Force
- **d** = Distance

Example: Danny is moving a box weighing 300N. He pulls it 3 m along a sloping ramp using a force of 200N. Calculate the work Danny does.

Solution:

Given:

- **F** = 200N
- **d** = 3m

Using the formula,

$$E = F \times d$$

$$E = 200 \times 3$$

$$E = 600\text{J}$$

Danny does **600** joules of work.

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3. What is Power and how is it measure?

- **Power** is the rate at which **work is done or energy** is transferred or converted per unit time.
- It measures how quickly energy is used, generated, or transferred.
- It is a **Scalar Quantity**.
- The SI unit of power is the watt (**W**).
- **Power** can be measured using the formula:

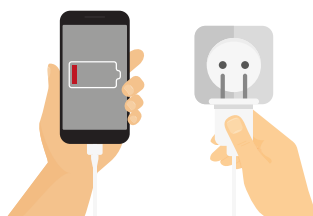
$$P = \frac{E}{t} \quad \text{or} \quad P = \frac{W}{t}$$

Where,

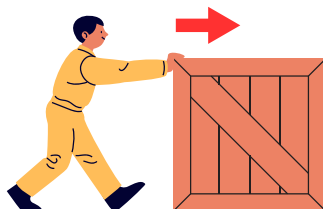
- **P** = Power
- **E** = Energy Transferred
- **t** = Time
- **W** = Work done

Example:

- When we charge our phone, electrical energy is transferred over time, and this rate of energy transfer is called power.



- When we push a box, energy is used to do work, and the rate at which this energy is used is called power.



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Example: A motor does 1200 joules of work in 6 seconds. What is the power of the motor?

Solution:

Given:

- **E** = 1200J
- **t** = 6s

Using the formula,

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

$$P = \frac{1200}{6}$$

$$P = 200$$

The Power of the motor is **200 watts**.

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4. How to Calculate Work and Power?

- Steps to Calculate Work

Steps#1: Identify the Term

Steps#2: Apply the formula

Steps#3: Calculate the Work

Example: A worker pushes a cart with a 30 N force over 5 m in the same direction. What is the work done?

Solution:

Steps#1: Identify the Term

- $F = 30\text{N}$
- $d = 5\text{m}$

Steps#2: Apply the formula

$$E = F \times d$$

Steps#3: Calculate the Work

$$E = 30 \times 5$$

$$E = 150\text{J}$$

Work done is 150J.

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- **Steps to Calculate Power**

Steps#1: Identify the Term

Steps#2: Apply the formula

Steps#3: Calculate the Work

Example: A boy runs up a flight of stairs and does 900 joules of work in 10 seconds. What is his power output?

Solution:

Steps#1: Identify the Term

- $E = 900\text{J}$
- $t = 10\text{s}$

Steps#2: Apply the formula

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

Steps#3: Calculate the Work

$$P = \frac{900}{10}$$

$$P = 90$$

The Boy's power output is **90 watts**.

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5. Solved examples

Problem1: A man pushes a box with a horizontal force of 50 N for a distance of 10 m along the floor. Calculate the work done.

Solution:

Steps#1: Identify the Term

- $F = 50\text{N}$
- $d = 10\text{m}$

Steps#2: Apply the formula

$$E = F \times d$$

Steps#3: Calculate the Work

$$E = 50 \times 10$$

$$E = 500\text{J}$$

Work done is 500J.

Problem2: A machine does 5000 joules of work in 20 seconds. Calculate the power of the machine.

Solution:

Steps#1: Identify the Term

- $E = 500\text{J}$
- $t = 20\text{s}$

Steps#2: Apply the formula

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

Steps#3: Calculate the Work

$$P = \frac{500}{20}$$

$$P = 250$$

The Power of the machine is **250** watts.

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6. FAQ

1. What is work?

Work is done when a force moves an object in the direction of the force.

2. What is the SI unit of work?

The SI unit of work is the joule (J).

3. When is no work done?

No work is done if:

- There's no movement.
- The force is perpendicular to the direction of movement.

4. What is power?

Power is the rate at which work is done or energy is transferred.

5. What is the SI unit of power?

The SI unit of power is the watt (W).

6. Is work a scalar or vector quantity?

Work is a scalar quantity.

7. Is power a scalar or vector quantity?

Power is also a scalar quantity.

8. What is the formula of work?

Formula for Work:

$$E = F \times d$$