

07: Work, Power and Energy

Key Physics Terms

- Force:** Any influence that tends to accelerate an object; a push or a pull. Measured in Newtons.
- Distance:** The quantity that describes the position of an object.
- Displacement:** The quantity that describes the change in location of an object and includes its direction of motion.
- Velocity:** The distance an object travels per unit of time including its direction of motion.
- Acceleration:** Rate at which an object's velocity changes with time; this change may in speed, direction, or both.
- Vectors:** A quantity that represents magnitude (size) and direction. It is usually represented with an arrow to indicate the direction; the arrow may be drawn to scale.
- Vector Components:** The perpendicular parts into which a vector can be separated and that act in different directions from the vector.
- Work:** Product of force on an object and the distance through which the object is moved.
- Power:** Work done per unit of time.
- Energy:** The ability to do work.
- Base level:** An arbitrary reference point from which distances are measured.
- Kinetic Energy:** The energy an object has due to its motion.
- Gravitational Potential Energy:** The energy an object has due to its position above some base level.
- Work-Energy Theorem:** The work done is equal to the change in energy.
- Conservation of Energy:** Energy is not created or destroyed, just transformed from one type to another.

Variables Used

- d = distance or displacement
- v = velocity
- a = acceleration
- t = time
- F = force
- Δ = change in
- θ = angle
- m = mass
- g = Acceleration due to gravity, = -9.8 m/s^2
- h = height above base level
- W = work
- P = power
- KE = kinetic energy
- PE = potential energy

Key Formulas

- $W = Fd = mad$
- $W = Fd \cos \theta$
- $P = W/t$
- $a = \Delta v / \Delta t$
- $\cos \theta = \text{adjacent} / \text{hypotenuse}$
- $KE = \frac{1}{2} mv^2$
- $PE = mgh$

Key Conventions

- If the force and displacement are in the same direction, the work is positive, +.
- If the force and displacement are in opposite directions, the work is negative, -.

Key Metric Units

- Force: Newtons, N
- Displacement: meters, m
- Energy: Joules, J, 1 Joule = $1 \text{ N} \cdot \text{m} = 1 \text{ kg} \cdot \text{m}^2/\text{s}^2$
- Work: Joules, J
- Power: Watts, W, 1 Watt = 1 J/s

How to Use This Cheat Sheet: These are the keys related this topic. Try to read through it carefully twice then write it out on a blank sheet of paper. Review it again before the exams.

Key Concepts

- Work is done only when a force acts in the direction of motion of an object.
- If the force is perpendicular to the direction of motion, then no work is done.
- Power is the ratio of work done per unit time.
- Any moving object possesses kinetic energy.
- When an object is lifted above some arbitrary base level position, its gravitational potential energy is increased.
- Energy may appear in different forms, but it is always conserved. The total amount of energy before and after some interaction is constant.
- Work and energy are interchangeable.

Typical Vector Diagrams



Component of force used in work calculation since this is the direction of motion.



Component of force used in work calculation since this is the direction of motion.

Work and Power Problem Solving Tips

These tips will make it easier to solve work and power physics problems:

- Thoroughly read the entire problem.
- Draw a diagram if needed.
- Identify all given information.
- Identify the quantity to be found.
- Select appropriate formula(s) that incorporate what you know and what you want to find.
- Convert units if needed. Use units throughout your calculations.
- Do any mathematical calculations carefully.
- When using trig functions, be sure your calculator is the correct mode (degrees or radians).
- When calculating work, be sure to use only the component of force in the direction of motion.
- For conservation of energy problems, try to identify the various types of energy in the situation. If possible, equate the energies to help solve for any unknowns.
- Check to see if your answer seems reasonable. If not, go back and look for errors.

Energy Specific Problem Solving Tips

These tips will make it easier to solve energy specific:

- For conservation of energy problems, try to identify the various types of energy in the situation. If possible, equate the energies to help solve for any unknowns.
- Often quantities like mass cancel out. This means you don't need to know these to calculate another variable.
- When assigning the base level, the ground or floor in the problem is usually a good choice.
- If energy seems to be missing or disappear, consider where the energy may have been converted. Heat, friction, and air resistance are common possibilities.

Pogil Answer Key Work Power

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Table of Contents Pogil Answer Key Work Power

1. Understanding the eBook Pogil Answer Key Work Power
 - The Rise of Digital Reading Pogil Answer Key Work Power
 - Advantages of eBooks Over Traditional Books
2. Identifying Pogil Answer Key Work Power
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Pogil Answer Key Work Power
 - User-Friendly Interface
4. Exploring eBook Recommendations from Pogil Answer Key Work Power
 - Personalized Recommendations
 - Pogil Answer Key Work Power User Reviews and Ratings
 - Pogil Answer Key Work Power and Bestseller Lists

5. Accessing Pogil Answer Key Work Power Free and Paid eBooks
 - Pogil Answer Key Work Power Public Domain eBooks
 - Pogil Answer Key Work Power eBook Subscription Services
 - Pogil Answer Key Work Power Budget-Friendly Options
6. Navigating Pogil Answer Key Work Power eBook Formats
 - ePub, PDF, MOBI, and More
 - Pogil Answer Key Work Power Compatibility with Devices
 - Pogil Answer Key Work Power Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Pogil Answer Key Work Power
 - Highlighting and Note-Taking Pogil Answer Key Work Power
 - Interactive Elements Pogil Answer Key Work Power
8. Staying Engaged with Pogil Answer Key Work Power
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Pogil Answer Key Work Power
9. Balancing eBooks and Physical Books Pogil Answer Key Work Power
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Pogil Answer Key Work Power
10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
11. Cultivating a Reading Routine Pogil Answer Key Work Power
 - Setting Reading Goals Pogil Answer Key Work Power
 - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Pogil Answer Key Work Power
 - Fact-Checking eBook Content of Pogil Answer Key Work Power
 - Distinguishing Credible Sources
13. Promoting Lifelong Learning

- Utilizing eBooks for Skill Development
- Exploring Educational eBooks

14. Embracing eBook Trends

- Integration of Multimedia Elements
- Interactive and Gamified eBooks

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