The Physics of Power

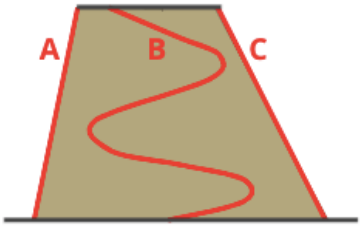
Lesson Notes

Learning Outcomes

- How are power and work different than one another?
- How do you analyze physical situations to determine the power delivered by an object?

Constrasting Work and Power

- Work pertains to a force causing a displacement in order to change the energy of a system.
- Power: how fast the work gets done. It has a time component.
- To illustrate: Consider three paths - A, B and C - leading from the base of a hill to the summit. Each has a different angle and requires a different time. Which requires the most work? … the most power?



Same work for each.

Most power: A

Least power: B

Defining Power

Power is the rate at which work is done.

Power = Work/Time or **P = W / t**

Two identical jobs require the same amount of work. But if one is to be done in less time, then it requires a greater power.

Unit: Watt (abbrev. W) 1 Watt = 1 Joule/second

Power Ratings

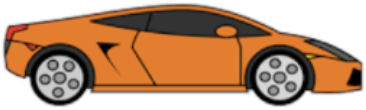
Machines are made to do work upon objects. Most machines are given a **power rating** to describe how fast they do the work. Power ratings are often given in the unit or **horsepower** (abbrev. **hp**).

1 hp = 746 Watt

Car A: 150 hp Engine

Goes 0 mi/hr to 60 mi/hr in 15 seconds.

Car B: 750 hp Engine



Goes 0 mi/hr to 60 mi/hr in 3 seconds.

Power-Force-Velocity Relationship

$$\text{Power} = \frac{\text{Work}}{\text{time}} = \frac{F \cdot d}{t} = F \cdot v$$

Power = Force • Velocity

Remember

v = d / t

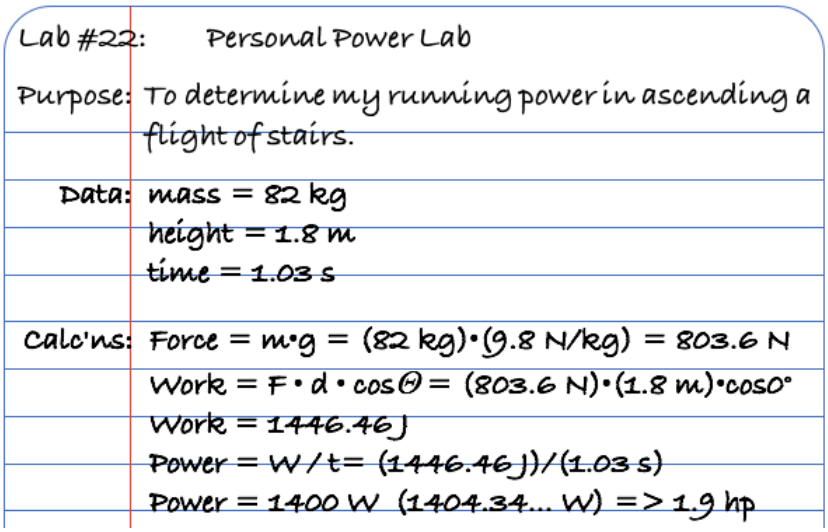
v = velocity
d = displacement
t = time

Personal Power Lab

A common lab in a Physics course.

Run up a flight of stairs and determine your power rating.

Typical data and calculations are shown.



Show your solution to each of the following problems.

Power Calculations - Example 1

When doing a chin-up, a 42-kg student lifts her body upward a distance of 0.25 m in 1.3 seconds. Determine the power delivered by the student's biceps.

Power Calculations - Example 2

During a football workout, the line coach stands on a training sled (combined mass = 245 kg) as three lineman push the sled across the field (μ=0.825) at a constant speed of 1.60 m/s. Determine the combined power of the lineman.