# Power, Energy, and Force

Pre-Lecture Questions

Problem Set #21 (due next time)

Lecture Outline

1. The Definition of Power
2. Power and Force
3. Power Production

## Pre-Class Summary:

The Work-Energy Theorem describes the relationship between the net work done on an object and the resulting change in speed. How quickly work is done is explained by

The Definition of Power: The rate at which work is done,

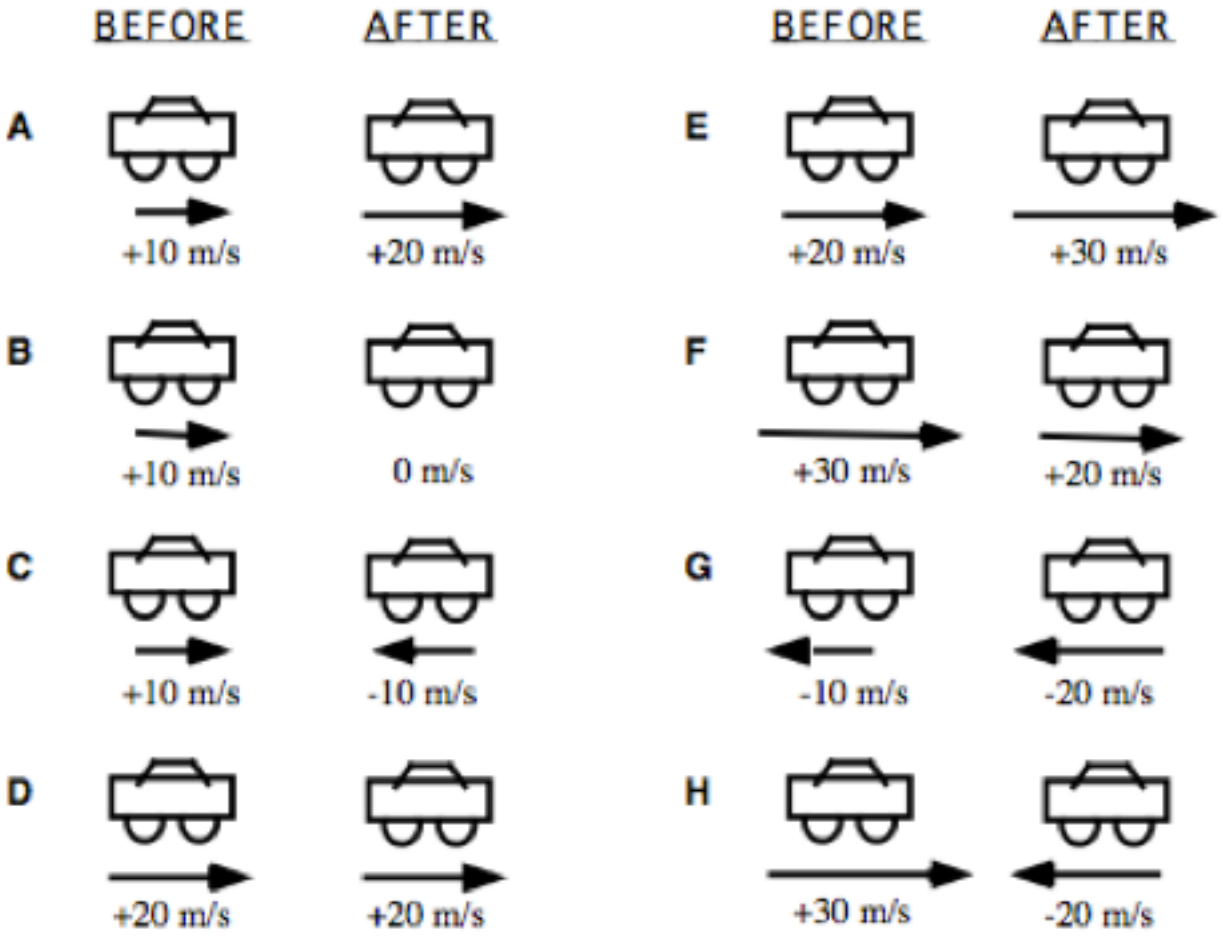
summarized mathematically as,

The Definition of Power $P \equiv \frac{dW}{dt}$ .

Power is related to the force or forces that supply it by,

The Power/Force Rule $P = \vec{F} \bullet \vec{v}$.

The eight situations below show before and after snapshots of a car's velocity. The time between the snapshots is the same in all cases. Rank these situations based upon the power supplied (positive) or extracted (negative) from the motion of the car. Rank the negative numbers lower than the positive numbers. All cars have the same mass and travel at the speed in the direction indicated.



*Example 1: Usain Bolt is one of the fastest human sprinters. He has a mass 0f 86.0kg and can accelerate from rest to 12.5m/s in 6.25s. Find the power he supplies in Watts and in horsepower.*

*Example 2: A real world sprint is a bit more complex. For one thing, the acceleration of a sprinter is not just dependent upon the forces they can cause the ground to generate, but air resistance plays a central role. Usain Bolt finishes his races at a constant speed of about 12m/s and feels an average force of air resistance of about 62N. Find the power he supplies at this point in the race.*

**Oroville Dam**

| Power station | |
|---|---|
| Hydraulic head | 615 ft (187 m)[4] |
| Turbines | 3x conventional<br>3x pump-generators |
| Installed capacity | 819 MW[4] |
| Annual generation | 2,200 GWh |

Oroville Dam is the tallest dam in the United States and the fifth highest earthen dam in the world.

1. Which figure "installed capacity" or "annual generation" has units of energy? Which has units of power?

2. Convert the units of energy into Joules.

## Largest Power Plants in California by Type

| Type | Name | Location | Capacity |
|---|---|---|---|
| Coal | ACE Cogeneration Facility | Trona, Inyo County | 108 MW |
| Nuclear | Diablo Canyon Power Plant | San Luis Obispo Cnty | 2,240 MW |
| Natural Gas | AES Alamitos Power Plant | Long Beach | 1,997 MW |
| Hydro | Shasta Dam | Redding | 676 MW |
| Wind | Alta Wind Energy Center | Kern County | 800 MW |
| Solar | Solar Energy Generating Systems | Mojave Desert | 354 MW |
| Geothermal | Calenergy (only one in CA) | Calipatria | 327 MW |

*Example 3: The table at the right lists light bulbs that all give off the same amount of light. Assume each type of bulb is used for six hours a day by each of the 14 million homes in California. Find (a)the total number of MW used for each kind of bulb and (b)the number of 1000MW power plants need for each type.*

| Bulb Type | Power Used |
|---|---|
| Incandescent | 60W |
| Compact Fluorescent | 13W |
| LED | 12W |

*The table below lists light bulbs that all give off the same amount of light and assume each type of bulb is used for six hours a day and electricity costs 12 cents per kilowatt-hour. Fill in the table.*

| Bulb Type | Power Used | Energy Used per Day (kWh) | Energy Used per Year (kWh) | Annual Cost ($) |
|---|---|---|---|---|
| Incandescent | 60W | | | |
| Compact Fluorescent | 13W | | | |
| LED | 12W | | | |

# Lecture 21 - Summary

The Work-Energy Theorem describes the relationship between the net work done on an object and the resulting change in speed. How quickly work is done is explained by

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