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Course: SPH 3U1
Unit: Mechanics

Lesson 10: Power

From **energy** ⇨→➔ **power**.

Here is another concept in physics that we need,
and one that we use in every day life without understanding it.
It's a little strange to be talking about this after discussing power plants.

Consider 5000 bricks. You have to lift them up to a roof. It doesn't matter how you carry them, the energy needed to move all 5000 is the same.
You know that the energy is $E_g = mg\Delta h$

How could you get the job done faster? Have more people moving the bricks, or maybe even a crane to lift the whole pallet of bricks at once.
What is the difference between a crane and hand carrying them? Just how fast the job happens. The same amount of energy is needed.

Power is simply the rate at which work gets done: P = W/t,
Since work is a transfer of energy, and W = ΔE ,
we may also think of power as being the rate at which energy gets transferred: P = ΔE/t
or more commonly P = energy / time , P = E/t
The units of power are joules per second, which is given the special name Watt (W) in honour of James Watt.
Note that a non-SI unit of power that is still in use is the horsepower (hp). 1 hp = 746 W

Why is power important?

How **fast** you can do work is often more important than the total amount of work done.

Consider driving an old school bus all around Canada; you can use millions of Joules of energy. A 400 ton jet goes down a 2 km runway and lifts into the air within 60 seconds.
The jet engine does an incredible amount of work in a very short time. It generates a huge amount of power. A school bus engine could never make the jet fly. It doesn't have the power.

- **Work transfers energy to an object.**
- **Power is the rate at which this is done.**

Sports cars have more powerful engines. It's possible to find the ratings of a Porsche engine in kiloWatts, but they also state the torque that the engine produces (which is related to power). And for motorcycles, the power of the engine is in cc (cubic centimetres!).

Light bulbs are rated in watts, but the amount of light produced changed dramatically depending on which technology you are using (incandescent, compact fluorescent, halogen, light emitting diode).

A 100W bulb (incandescent) is a lot brighter than a 60W bulb because it converts electrical energy to light (and heat) faster. The light fixtures all have a maximum power rating. If you put a 200W bulb into a lamp that can only handle 100W, the fixture cannot dissipate all of the heat fast enough. The bulb is generating so much light and heat every second that the lamp will overheat and catch fire.

With more efficient electronics we use less power. Computer power supplies used to be around 700 W, but now they are around 500W.

Other very powerful machines (google these for videos or images):

- Tunnel boring machines (TBM) https://www.youtube.com/watch?v=Dk-8Q42NCSQ *(must be powered by electricity so that fumes are not created killing the people)*
- Bucket scoop coal mining machines https://www.youtube.com/watch?v=Y7zIZVlMtFY (*one accidentally scooped up a bulldozer)*
- Large jet engines produce about 23 MW of power when cruising *(but again, they specify power with weird units: "pounds of thrust")*
- The Saturn V rocket to the moon had 5 engines in its first stage, each producing 41 MW of power.
- Niagara falls power plants: total power generated = 4,900 megawatts.
- Nuclear power plants in Canada: around 800 MW each.
- Ontario generates up to 5400 MW of power from wind turbines. Our wind turbines are about 2.3 MW each.
- Porsche engine: https://www.porsche.com/international/models/panamera/panamera-models/panamera-4s/featuresandspecs/