Lesson 41: Power

The word "**power**" is most often associated with electricity in everyday use, but this is not the case in physics.

- **Power** is the rate at which work is done.
    - This means that **power** measures how quickly energy is being used.
- Since it is the rate at which something is happening, time must be involved somehow.
- If you look at the basic formula for power, you'll see that it is the same as many formulas that involve time.

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

P = power (Watts)
W = Δ E = work (Joules)
t = time (seconds)

Power is really how fast you are using up energy, so it could be measured in Joules per second.

- In honour of his search for a more efficient engine (which was better at converting energy!), the unit for **power** is called the **Watt** after James Watt.
- Think of a light bulb… you always talk about how many Watts the bulb is, like a 60 W bulb.
    - That just means that the light bulb is using 60 Joules of energy every second.

Example 1: I left a 150W bulb on for 2.5 hours. **Determine** how much electricity I used.

In this case the electricity (electrical energy) is being changed into heat and light…that's the work done!

Warning!
Electricity is NOT power. Electricity is energy.

$$P=\frac{\Delta E}{t}$$
$$\Delta E=Pt$$
$$\Delta E=150(9.0e3)$$
$$\Delta E=1.35e6=1.4e6\,J$$

Remember to change 2.5 h into seconds.

You used over a million Joules of energy!!!

In many questions we need to look at situations where an motor is lifting something at a constant velocity.

- The difference between motors is that a higher power motor will be able to move the load faster.
- We can see this if we start to play with the formula a bit.

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

Since v = d / t , we can substitue it out.

- You can only use this in situations where the object is being moved at a constant velocity.

Example 2: A 200 W motor is being used to lift shingles at a constant velocity to the top of a roof. If one pack of shingles has a 28 kg mass, **determine** the velocity that the pack will be raised at.

If the shingles are being raised at a constant velocity, then the net force acting on the pack is zero (any net force would cause acceleration).

$$F_{NET}=F_a+F_g$$
$$0=F_a+F_g$$
$$F_a=-F_g$$
$$F_a=-mg$$
$$F_a=-28(-9.81)=274.68\,N$$

Now we can calculate the velocity...

$$P=Fv$$
$$v=\frac{P}{F}$$
$$v=\frac{200}{274.68}$$
$$v=0.72812=0.73\,m/s$$

Example 3: The power output of a car is usually measured in the non-metric unit horsepower (hp). A car that we are looking at has an engine rated at 120 hp, which is the same as 8.95e4 W. If the car is moving against air resistance of 4.00e3 N at a constant velocity, **determine** how fast the car is moving.

$$F_{NET}=F_a+F_f$$
$$0=F_a+F_f$$
$$F_a=-F_f$$
$$F_a=-(-4.00e3)=4.00e3\,N$$

$$P=Fv$$
$$v=\frac{P}{F}$$
$$v=\frac{8.95e4}{4.00e3}$$
$$v=22.375=22.4\,m/s$$

Homework

p325 #1-3
p328 #3, 4