

Big Exam #2: PHYS 320

In Midterms, you are allowed a calculator and notes with 50 bits of information. However, in this big exam, please work out your answers without a calculator. I will be looking for proper canceling of units. Precision is not important.

- 1) True story: I left my 50W stereo blaring loud while I was a school: 10 hours!
 - a) How much energy did it use? Please provide answer in Joules and kWh.
 - b) How much did this add to my electricity bill?
 - c) Should I be able to feel the heat coming from my stereo at this amount of power, or is it all given out in sound (wave) energy?

Many folks converted the total energy into Joules. However, kWh would be much easier because we have the time in hours already and the cost of electricity is about 15 cents / kWh... already in units of kWh. The single most important formula in this class is $P = \frac{\Delta E}{\Delta t}$, please start with that! The amount of energy in sound is minimal. We are very sensitive at sensing sound. For instance, a sonic boom is about 1 W, and 1 W/m² sound intensity corresponds to 120 decibel, capable of damaging the ear. So, very little of the 50 W of a stereo is going into sound energy. Mostly it's lost to thermal energy. You can feel the warmth coming from a stereo. 50W is enough to make a small box quite warm.

a) $P = 50W$ $\Delta t = 10 \text{ hours}$

A $\Delta E = P \Delta t$
 $= 50W \cdot 10 \text{ hours} \left(\frac{3600s}{1 \text{ hour}} \right) \cdot \left(\frac{3600s}{1 \text{ hour}} \right) \cdot \frac{1,800,000}{500}$

$\Delta E = 1.8 \text{ MJ}$
 $\Delta E = 0.5 \text{ kWh}$

Probably a little low... but ok

b) ASSUME $\sim 0.12/\text{kWh}$

$\$0.12/\text{kWh} \cdot 0.5 \text{ kWh} = \boxed{\$0.06}$

c) YOU SHOULD BE ABLE TO FEEL SOME HEAT LOSSES, AS THE STEREO IS NOT 100% EFFICIENT.

50W is a power flow that would make a small box hot.

2) About what is the maximum power that your body can put out for:

- a) 5 seconds
- b) an hour

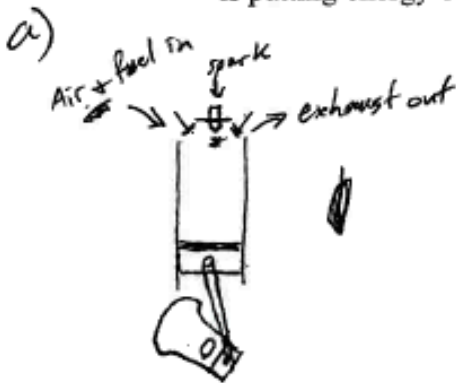
(no calculations necessary) This is an estimate and your knowledge of your body and what is reasonable. There were many people who claimed that they would put out more power over a longer time, than over a shorter time, indicating that they are not properly distinguishing Power from Energy. For reference, please see the graphic produced by NASA: <https://www.moorepants.info/presentations/human-power/images/powerVSduration.png>

a) $\sim 700\text{ W}$ (I AM NOT AN OLYMPIC BICYCLIST)

b) $\sim 500\text{ W}$ \Rightarrow LESS OUTPUT OVER LONGER TIME INTERVAL
that's a little high for a regular person.

3) With good labeled drawings, please explain

- a) How an Otto Cycle (gasoline car engine) works.
- b) Additionally, please explain where I am putting energy into the machine and when the machine is putting energy out.



- Down stroke intakes fuel + air (intake)
- Upstroke compresses air mix (compression)
- Spark combusts air + fuel mix
- Air expands to create power stroke downward } (Powerstroke)
- ~~spark~~ - Exhaust opens to clear cylinder (exhaust)

4 strokes

- b) - Work is being put in at the compression stroke ~~and spark~~
- Work is put out during the power stroke

great