

Physics for future Presidents

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Homework 14, due in recitation on Wednesday, November 20th

Carbon dioxide emissions

How much carbon dioxide does a typical 1 GW coal-burning power plant emit during one year?

Let's find out!

Coal is basically pure carbon (we'll not be concerned with nitty-gritty details here). The energy upon burning is ultimately the result of the following chemical reaction:



which means that a single atom of carbon combines with a molecule of oxygen gas to form one molecule of carbon dioxide, CO_2 , a process by which some energy is released. How much this is can be found out from any good chemistry textbook. One finds that it is about 4 eV, or 6.4×10^{-19} J.

1. How many seconds does one year have?
2. How much *electric* energy does a 1 GW power plant produce in one year?
3. If the power plant has a typical efficiency of 35%, how much *thermal* energy has to be produced by coal-burning to get the *electric* energy you calculated in the previous problem?
4. How many reactions of the form " $\text{C} + \text{O}_2 \rightarrow \text{CO}_2 + \text{energy}$ " does it take to produce that much thermal energy in the power plant?
5. Every single individual chemical reaction produces one molecule of CO_2 , which has a mass of about 7.33×10^{-26} kg. Now you're ready to give an answer to our question: What's the total mass of carbon dioxide released into the atmosphere by such a power plant during one year? Give your answer in "tons".