**ATOC 3500/CHEM 3151 Spring 2018**

**Problem 18**

**VOC Emissions, Particulate Mass, and Visibility**

In the polluted urban atmosphere, volatile organic (VOCs) released from activities such as barbeques, fast-food restaurants, gas-powered lawn mowers, paint, etc., react photochemically to produce more oxidized compounds that tend to condense and form small particles (particulate matter, or PM). As we have seen in previous problems and discussions in class, it doesn’t take much particulate matter to reduce visibility, only about 20-30 g m-3 will ruin a good view! This problem will explore the relationship between the mass of particulate and the gas-phase mixing ratio of the precursor necessary to produce that amount of particulate. Recall that pollutants such as ozone, carbon monoxide, and NOx are often present at ~100 parts per billion in a polluted atmosphere. We’ll see how much particulate a similar amount of hypothetical organic molecule can produce.

1. Assume that on a moderately smoggy day in Los Angeles, combined emissions of VOCs contribute about 100 ppb (by number, NOT mass) to the atmosphere. Assume that these VOCs react with oxidants such as OH and O3 to form particulate matter with 10% efficiency – that is, 10% of the initial 100 ppb will eventually end up as particles (the rest produces gaseous compounds, like CO, CO2, O3, PAN which we don’t consider in this problem). Assume that the average mass of the organic molecule that condenses is 100 g mole-1. How much PM (in g m-3) would be produced? (use a pressure and temperature of 1000 mb and 300 K)
2. Recall that visibility is dependent on the cross section for particulate scattering, which for an individual particle is equal to 2R2. Suppose some other compounds in the atmosphere added to this particulate matter from VOCs (example – ammonium, nitrate, and sulfate) so that the total the atmosphere PM was much higher than your calculation. Say there was 100 g m-3 (note that m-3 refers to air, in this case). Assuming that these particles have an average density of 1.75 g cm-3 and a radius of 0.25 m (in thiscase, the cm-3 refers to the condensed phase, NOT the air), how large would the total scattering cross section be (in m2) in a cubic meter of AIR? How much larger would this total scattering cross section be if the same PM mass (100 g m-3) consisted of a larger number of smaller particles – say, radius of 0.125 m instead of 0.25 m?