

CHEM 302 Assignment #4

Answers the following questions and submit solutions to even numbered questions ONLY in a neat and well organized manner, including dimensional analysis, where appropriate. Reference data and information sources.

Due: Thursday, December 3rd, 2015

1. Use Plank's law to plot blackbody radiation spectra between wavelengths of 0.1 and 100 μm for $T = 300\text{K}$ and 6000K using Excel. *Hint; use about 350 rows for the wavelengths in column A incrementing them by a factor of 1.02 for each row. Display plot on a log-log scale.*

2. Describe how catalytic converters on automobiles act in a dual role in catalyzing both reduction and oxidation reactions. (*Use chemical equations to illustrate your answer*).

3. A one compartment home of 400 m^3 has a ventilation rate of 0.30 air changes per hour with its doors and windows closed. Carbon monoxide is produced from a kerosene heater at a rate 1 g per hour. How long will it take before the indoor concentration exceeds the toxic action threshold level of 100 ppm_v ?

4. Calculate the steady state concentrations of carbon dioxide inside an office building in summer and winter conditions with air changes per hour ranging from 5.0 to 0.1 ach. Building volume = $20,000 \text{ m}^3$, Rate of internal CO_2 emission = 10 kg hr^{-1} . Assume the outdoor CO_2 concentration is 400. ppm_v .

5. Given that the gasoline is about 85% by mass carbon and has a density of about 0.75 kg/L, estimate the adjusted ‘life cycle’ cost that would need to be added to a liter of gasoline that would offset the cost associated with carbon capture and sequestration (CCS) at \$200/tonne of CO_2 .

6. The explosions and fires from a major nuclear war would result in so much soot and particulate aerosols, that the Earth’s *albedo* is predicted to increase by 20%. Calculate the resulting average annual Earth temperature that would result.

7. Information about the average chemical composition and energy content of the three major fossil fuels and global consumption rates are summarized below.¹

	Average composition	Percent combustible of total	Worldwide consumption 1980 ($\times 10^{18}$ J/yr)	Energy content
Petroleum	$\text{CH}_{1.5}$	98% (w/w)	135	43×10^6 J/kg
Natural Gas	$\text{CH}_{3.6}$	88% (v/v)	60	3.9×10^7 J/m ³ (STP)
Coal	$\text{CH}_{0.8}$	75% (w/w)	90	29.3×10^6 J/kg

- What mass of CO_2 was released to the atmosphere in 1980 from fossil-fuel burning?
- Rank these fossil fuels based on the mass of CO_2 released per Joule of energy produced.

8. What is meant by the term ‘*Global Warming Potential*’ and why is it high for nitrous oxide and relatively low for nitric oxide and nitrogen dioxide?

¹ Adapted from **Consider a Spherical Cow: A Course in Environmental Problem Solving**, John Harte, University Science Books, Mill Valley, CA, 1988.