Name ______________________________ Sample Exam

CE 326 Principles of Environmental Engineering - First Exam

Defendable True/False. If the statement is true as stated, mark it OK. If it is false, correct it by changing the underlined word or words in the sentence so that it will be true. 3 points each.

1. Indirect chemical attack occurs when pollutants are absorbed and react with components of the absorbent to form a destructive compound (e.g., oxidant, reductant, or solvent) .

2. Converting 100 ppm by volume of SO_2 at 25EC and 101.325 kPa to ppm by volume at 50EC and 101.325 kPa reults in a concentration of 200 ppm (PV = nRT, where R=8.3143 Pa·m^3/K·mole, and MW_{SO2} = 64 g/mole).

3. The majority of particulate emissions are from mobile sources.

4. Nitrous oxide is an odorless, colorless gas that reacts with hemoglobin in the blood and is lethal to humans within a few minutes at concentrations exceeding 5,000 ppm.

5. Hydrocarbons, VOCs, and lead from automotive emissions contribute to photochemical smog which is the primary reason that polluted cities are called non-attainment areas for ozone.

6. The stability of the atmosphere at prevailing conditions is often used in air dispersion models to describe vertical mixing of air: a less stable atmosphere providing increased ground level concentrations of pollutants.

7. The heat island effect causes the atmospheric stability to be less over a city than the surrounding countryside, increasing the countryside ground level concentrations for tall stacks on stable days.

8. On a per person average, Americans throw away a ton of solid waste every 30 days.

9. The acronym “NIMBY” related to siting a landfill stands for “not in my life baby.”

10. In a cancer risk assessment the greater the slope factor the less the risk of cancer.

11. Chlorofluorohydrocarbons contribute to both the greenhouse effect and ozone depletion.

12. Water vapor is the most abundant greenhouse gas.

Short Answer Problems - 8 points each:

13. How do modern sanitary landfills minimize many of the environmental problems associated with open dumping (air, water, and land). Use sketches as needed.

15. What are the three things about Superfund that have caused extensive litigation.

16. Define hazardous waste and how a waste is determined to be a hazardous waste.

Numerical Problems (20 pts each).

16. Using the residential default parameters (outdoor) for the general risk model, how long could a person live (in years) at the site boundary of a dioxin source if the concentration (RBSL) at the site boundary is 3×10^{-14} g/m^3 to have a one in a million chance of getting cancer throughout his/her lifetime? Assume the person will live an average life span of 70 years and spend 350 days per year at the site boundary.

The general risk model is:

$$TR = \frac{RBSL \cdot IR \cdot EF \cdot ED \cdot SF_i}{BW \cdot AT_C \cdot 365 \frac{d}{y} \cdot 10^3 \frac{\mu g}{mg}}$$

Risk model parameters

Parameter		Residential Default	Commercial/Industrial
TR = target risk		for example, 10^{-4} to 10^{-6}	for example, 10^{-4} to 10^{-6}
RBSL = risk based screening level, μg/m^3		chemical/site specific	chemical/site specific
IR = inhalation rate, m^3/d	(indoor)	15	20
	(outdoor)	20	20
EF = exposure frequency, d/y		350	250
ED = exposure duration, y		30	25
BW = body weight, kg		70	70
AT_c = averaging time for carcinogen, y		70	70
SF_i = slope factor for inhalation (mg/kg d)$^{-1}$		chemical specific	chemical specific

Sample slope factors for risk model

Slope Factors	SF_i
Benzene	0.029
Benzo(a)pyrene	7.3
2,3,7,8-TCDD (dioxin)	1.5×10^5

16. A major chemical manufacturing company wants to build an incinerator to destroy dioxin contaminated waste that has been stockpiled in a nearby warehouse. After incineration and dispersion to the site boundary (see diagram) they predict that the ground level concentration of dioxin for a recipient at the site fence line directly downwind must not be greater than 3.0×10^{-14} g/m^3. At this concentration, how high must they make the stack if the emission rate of dioxin is 1.5×10^{-8} g/s.

Given:
Wind speed = 5 m/s
Temperature of stack gas = 300 °C ; Temperature of air = 30 °C ; atmospheric pressure = 100 kPa
Stack diameter (d) = 5 m, stack velocity (v_S) = 10 m/s
Stability Class C, using Martin's equation: $s_y = 104.0X^{0.894}$ and $s_z = 61.0X^{0.911}$
where the dispersion coefficient is in meters and the X distance is in km

$$\chi = \left(\frac{E}{\pi s_y s_z u}\right)\exp\left(-\frac{1}{2}\left(\frac{y}{s_y}\right)^2\right)\exp\left(-\frac{1}{2}\left(\frac{H}{s_z}\right)^2\right)$$

$$H = h + \nabla H$$

$$\nabla H = \frac{v_S}{u}\left[1.5 + \left(2.68x10^{-2}(P)\left[\frac{T_S - T_a}{T_S}\right]d\right)\right]$$

where delta H is the plume rise and u and v_S are in units of m/s, P is in kPa, $T_{S,a}$ are in degrees K, and d is in m.