

PUAF 741

Global Environmental Problems

FINAL EXAM

15 December 1998, 4:30–7:30 pm, room 1107 VMH

Please enter your student number here: _____

Begin by reading the entire exam. Do the easiest problems first.

This exam contains 100 points. Allocate your time accordingly (i.e., about 9 minutes per 5-point problem).

This is a closed-book exam, except for one sheet of notes. Possibly useful information is attached. Calculators are allowed; computers are not.

Enter all answers and do all your work on this exam. If you need more space, use the other side of the sheet.

Quantitative questions should include an appropriate number of significant digits and the proper units. **Circle final answers.** Partial credit for incorrect answers can be given only if you show your work, *and only if your handwriting is legible*. If you need a number you can't find or derive, define a symbol for it or take a guess as to its value and continue. If you don't have time to complete a problem but think you know how to do it, describe the steps. If you know your answer is incorrect, let me know. If you believe that you need more information to answer the question, ask me.

Qualitative questions should be answered as precisely and succinctly as possible. *Make sure your handwriting is legible.* Style is unimportant.

Exam scores and course grades will be posted on the course web site.

Good luck!

2. It is estimated that planting a million trees in Los Angeles would reduce summer temperatures by 4 °F, saving \$175 million in cooling costs.

A. If each tree costs \$300 to plant and \$75 per year to maintain, is this a cost-effective way to reduce electricity consumption? (5 points)

B. Trees reduce carbon emissions by reducing electricity consumption. If a kilowatt-hour of LA electricity costs \$0.1 and results in the release of 100 grams of carbon, estimate the reduction in emissions. (5 points)

C. Trees also sequester carbon. Which has a greater effect on emissions: sequestration or reduced electricity consumption? Assume the trees mature in 50 years, at which time they contain 5 tons of carbon. (5 pts)

4. It is estimated that there are 10 million species on Earth, of which 70 percent are found only in tropical forests. Between 1960 and 1990, the area covered by tropical forests declined from 2.20 to 1.76 billion ha.

A. Estimate the total loss of species during this time period. Assume that $S \approx S_0(A/A_0)^{0.25}$, where S is the number of species and A is the area of the forest. (5 points)

B. How does this compare to the natural rate of extinction? (2 points)

C. What are the uncertainties in the above analysis? (3 points)

5. The 1990 amendments to the Clean Air Act reduced U.S. sulfur dioxide emissions from 20 to 10 Mt. In addition, it reduced NO_x emissions from automobiles from 1.0 to 0.4 grams per mile. Which provision will have the greatest effect on acid deposition? Assume that NO_x is mostly NO_2 , and that equal fractions of SO_2 and NO_2 are converted to H_2SO_4 and HNO_3 , respectively. What important consideration does this simple calculation ignore? (10 points)

6. In 1985, 300,000 metric tons of CFCl_3 (CFC-11) were produced. The residence time of CFC-11 in the atmosphere is estimated at 60 years.
- A. If production remained constant, estimate the steady-state concentration of CFC-11 in the atmosphere, in ppbv (5 points).

B. CFC-11 is destroyed in the stratosphere, not the troposphere. What is the steady-state concentration in the stratosphere? Assume that 90 percent of the atmosphere is in the troposphere and 10 percent is in the stratosphere, and that CFC-11 has a residence time of about 10 years in the troposphere. (5 points)

POSSIBLY USEFUL INFORMATION

1 meter (m) = 3.281 feet (ft)	1 mole(gas) = 22.4 L @ STP
1 mile (mi) = 1609 m = 5280 ft	1 hour (hr) = 3600 seconds (s)
1 hectare (ha) = 10^4 m^2 = 2.47 acres	1 year (yr) = $3.155 \cdot 10^7 \text{ s}$
1 m^3 = 1000 liter (L) = 1 te(H_2O)	1 Joule (J) = $\text{kg} \cdot \text{m}^2/\text{s}^2$
1 gallon (gal) = 3.754 L	1 BTU = 1055 J
1 barrel (bbl) = 42 gal	1 kilowatt-hour (kWh) = 3.6 MJ
1 kilogram (kg) = 2.205 pounds (lb)	1 Watt (W) = 1 J/s
1 tonne (te) = 1000 kg	1 horsepower (hp) = 746 W
1 mole = $6.02 \cdot 10^{23}$ molecules	Kelvin (K) = degrees Celsius + 273

$S = F \cdot \tau$	$\text{pH} = -\log_{10}[\text{H}^+]$
$S(t) = S(0) \cdot e^{rt} = S(0) \cdot (1 + i)^t$	$[\text{H}^+] = \text{moles}(\text{H}^+) \text{ per liter } \text{H}_2\text{O}$
$i = [S(t)/S(0)]^{1/t} - 1 = e^r$	area of Earth = $5.10 \cdot 10^{14} \text{ m}^2$
$r = \ln[S(t)/S(0)]/t = \ln(1+i)$	mass of atmos. = $5.14 \cdot 10^{18} \text{ kg}$
$\log(a \cdot b) = \log(a) + \log(b)$	moles of dry air = $1.78 \cdot 10^{20}$

$$k = 10^3; \quad M = 10^6; \quad G = 10^9; \quad T = 10^{12}; \quad P = 10^{15}; \quad E = 10^{18}$$

$$m = 10^{-3}; \quad \mu = 10^{-6}; \quad n = 10^{-9}; \quad p = 10^{-12}; \quad f = 10^{-15}; \quad a = 10^{-18}$$

Atomic weights: H = 1; C = 12; N = 14; O = 16; S = 32
