

THE UNIVERSITY *of York*

**Degree Examination 2007**

**ENVIRONMENT DEPARTMENT**

**BSc Environment, Economics & Ecology  
BSc Environmental Science  
Part 2**

**CURRENT ISSUES IN ATMOSPHERIC SCIENCE**

Time allowed: **two hours**

Answer **ANY TWO** questions

Calculators will be provided

*Pay adequate attention to spelling, punctuation and grammar, so that your answers  
can be readily understood*

### **Question 1**

a. Indoor air pollution is a relatively new issue for atmospheric scientists. What are the sources of indoor air pollution and which species do they give rise to indoors?  
**(15 marks)**

b. State three reasons why you would expect indoor and outdoor air chemistry to differ.  
**(6 marks)**

c. Why might future increases in background tropospheric ozone effect indoor air chemistry and how?  
**(4 marks)**

d. Describe the differences between El Niño Southern Oscillation (ENSO) and non-ENSO conditions.  
**(20 marks)**

e. Define teleconnections and give two examples that occur during ENSO events.  
**(5 marks)**

## Question 2

a. Define the chemical lifetime of a species X with respect to OH. Explain each of the terms in your definition and give the units.

**(5 marks)**

b. Given a global average OH concentration of  $1.1 \times 10^6 \text{ molecule cm}^{-3}$ , calculate the lifetimes of the following species with respect to OH:

Species X	$k_{(\text{OH}+\text{X})} \text{ cm}^3 \text{ molecule}^{-1} \text{ s}^{-1}$
Isoprene	$1.0 \times 10^{-10}$
$\alpha$ -pinene	$5.3 \times 10^{-11}$
Ethene	$8.5 \times 10^{-12}$
$\text{CH}_2\text{F}_2$ (a HCFC)	$1.1 \times 10^{-14}$
$\text{CCl}_4$ (a CFC)	$3.1 \times 10^{-16}$

Use the appropriate units for your answer, *e.g.* hours, days, years.

**(15 marks)**

c. At which latitudes would you expect to find the highest production rates of OH and why?

**(5 marks)**

d. How does the form of  $\text{NO}_x$  change as you move from the source of pollution (*e.g.* an exhaust pipe) to the clean atmosphere?

**(5 marks)**

e. What are the implications of your answer to 2d for ozone formation and where would you expect to find the highest concentrations?

**(10 marks)**

f. What is the effect on  $\text{NO}_2$  concentrations in urban and rural areas when  $\text{NO}_x$  emissions are reduced?

**(10 marks)**

### Question 3

Climate change is the major issue for today's atmospheric scientists, owing to its potentially devastating impacts for many. Although the causes of climate change are increasingly understood and accepted, there is an obvious need to undertake research in this area, in order to be aware of any impacts, and to propose possible mitigation measures. Using recent literature to illustrate your answer, discuss recent research in the area of climate change and explain how the results may impact on society. You should include a discussion of the uncertainties based on the research you highlight and set the results in the wider context of climate research.

**(50 marks)**

### Question 4

a. What are the three reactions that link  $\text{NO}_x$  and  $\text{O}_3$  chemistry in the troposphere and how would you describe the resulting relationship?

**(10 marks)**

b. How are peroxy radicals formed in the atmosphere? Illustrate your answer with one example each for clean and polluted air.

**(10 marks)**

c. Show how the presence of peroxy radicals perturbs the reactions you described in your answer to part 4a. What are the implications of this perturbation?

**(7 marks)**

d. How does the combustion of a carbon/hydrogen fuel lead to products such as  $\text{CO}$ , hydrocarbons,  $\text{NO}_x$  and heavy metals, as well as  $\text{CO}_2$  and  $\text{H}_2\text{O}$ ?

**(15 marks)**

e. What is the composition and origin of  $\text{PM}_{2.5}$  and  $\text{PM}_{10}$  in the atmosphere?

**(8 marks)**

