UNIVERSITY OF OSLO
DEPARTMENT OF ECONOMICS

Postponed exam: **ECON4910 – Environmental economics**

Date of exam: Friday, August 11, 2006

Time for exam: 9:00 a.m. – 12:00 noon

The problem set covers 2 pages

Resources allowed:
- No resources allowed

Please answer all questions. In the evaluation they will be given equal weight.

The grades given: A-F, with A as the best and E as the weakest passing grade. F is fail.

Question 1

Consider two firms that produce the goods x and y respectively. The benefit to society from producing these two goods is $A(1 - \text{Exp}(-x)) + B(1 - \text{Exp}(-y))$. Production of the two goods imply that pollution, P, is produced according to the formula $P = ax + by$.

a) It is decided that P should not exceed P^*. Find the levels of x and y that maximize benefits to society given this constraint.
b) A regulator decides that the two firms are to be given permits to emit $P^*/2$ each. Both firms can be assumed to be competitive price takers in an emission market. Derive the firms' demand for emission rights and use this to find the equilibrium in emission permits. Assume that there are no transaction costs and perfect information in the permit market.
c) From the above answers, find an expression for how $A(1 - \text{Exp}(-x)) + B(1 - \text{Exp}(-y))$ depends on P^*.
d) The regulator learns that the damage from pollution is given by DP where D is a positive constant. Find the optimal P^* given that the firms trade. Can the optimal P^* be zero?

Question 2

The regulation of greenhouse gases implies that we need to consider the regulation of emissions over time. Assume that the instantaneous damage from atmospheric greenhouse gases, x, is given by $\frac{1}{2}x^2$ and that the cost of reducing emissions below the unregulated level u^0 is given by $\frac{1}{2}(u^0 - u)^2$. Further, assume that the stock of x develops according to $\dot{x} = u - \delta x$, $x(0)$ given. The rate of time preference is given by r.

a) Formulate the control problem that solves the greenhouse gas problem over an infinite time horizon and derive the optimality conditions. (You do not have to find explicit functions that solve the problem.)
b) Calculate the steady state values of u, x and the shadow price.
c) Illustrate the optimal solution in a phase diagram.
d) Illustrate in the phase diagram the effect of an increase in r.

Question 3

Discuss in a short essay the problems that are raised by private information in environmental regulation.