

OLLSCOIL NA hÉIREANN
GAILLIMH

NATIONAL UNIVERSITY OF IRELAND
GALWAY

SEMESTER 1 (WINTER) EXAMINATIONS 2000-01

Unit EP328: Physics of the Environment I
Unit CE432: Airborne Pollution

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Time allowed: ONE AND A HALF hours	Answer THREE questions, at least one from Section A and one from Section B
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SECTION A

- Q.1 Define the following: mixing ratio, saturation vapour pressure, specific heat capacity. Explain how the relative humidity of an air mass can increase without its water vapour content increasing.

State Wien's Displacement Law. If the surface temperature of the Sun is 6000K, and Wien's constant is $2.9 \times 10^{-3} \text{ m K}$, at what wavelength does the Sun emit its maximum radiation intensity?

Outline the principle of operation of (a) a hot-wire anemometer and (b) a sling hygrometer (psychrometer).

- Q.2 Compare and contrast gaseous and particulate air pollutants (giving examples where appropriate) in terms of the transport processes by which they move into and through the indoor environment.

In a building which is close to outdoor sources of carbon monoxide and nitrogen dioxide gases (assume no indoor sources), the equilibrium indoor/outdoor concentration ratio of one of the gases is 0.97 and the equilibrium indoor/outdoor concentration ratio of the other is 0.45. Which ratio is likely to refer to which gas? Give a reason for your choice. Based on your choice, and given that the air exchange rate (λ_r) for the building in question is 0.5 hr^{-1} , determine the indoor surface absorption rate (λ_a) of nitrogen dioxide.

Which would you expect to have a higher average air exchange rate: (a) the UK building stock or (b) the Norwegian building stock? Explain your choice.

Q.3 Explain what is meant by the following terms:

aerosol, equivalent volume diameter, aerodynamic diameter, geometric mean diameter, PM_{10} .

In regard to inhalation of aerosol, explain why the nose is a more effective filter of aerosol particles than the mouth.

Differentiate between inhalable fraction, thoracic fraction and respirable fraction of aerosol particles. Comment briefly on the influence of aerosol particle size in the fractional deposition of aerosol in the respiratory tract during inhalation.

SECTION B

Q.4 If a workplace contains four milling machines which produce a total sound level intensity of 86 dB, what is the sound level intensity associated with one machine?

Describe with the aid of diagrams the effects of the temperature profile in the atmosphere on the dispersion of a point source of pollutant.

Determine the stability conditions in the atmosphere for the following measurements of temperature (T) with height (H). The temperature profile may be assumed to be linear between the two heights in each case.

CONDITION 1	(H = 10 m, T = 7.11 °C) and (H = 202 m, T = 3.09 °C)
CONDITION 2	(H = 2 m, T = -3.05 °C) and (H = 318 m, T = -6.21 °C)
CONDITION 3	(H = 18 m, T = 14.03 °C) and (H = 286 m, T = 16.71 °C)

Q.5 Answer parts (a) *and* (b):

(a) A power plant burns coal at the rate of 2 kg per second. The coal used contains 1.5% sulphur by weight. If the combustion process is 95% efficient (i.e. 5% ends up in the ash), estimate the SO_2 emission in grams per second. The gram molecular weight of sulphur is 32 and that of oxygen is 16.

(b) At a location downwind from the power plant the concentration of SO_2 was measured as $25 \mu g/m^3$. Find the equivalent concentration in ppm (parts per million). The temperature and pressure at the time were 20 °C and 1030 hPa.

Note: one mole of an ideal gas occupies 22.414 litres at standard conditions of 0 °C, (273.15 K) and 1013.25 hPa.