

OLLSCOIL NA hÉIREANN
GAILLIMH

NATIONAL UNIVERSITY OF IRELAND
GALWAY

SUMMER EXAMINATIONS 2000

Unit EP327- Physics of the Environment

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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

EP327 - Physics of the Environment

SECTION A

- Q.1 List four typical constituents of the flue gases from a conventional coal-fired power station, and outline the steps that could be taken to remove any one of them.

A farmer runs 50 x 75 Watt lamps in his pig house, and these operate 24 hours per day. He receives 20% of this power requirement from a windmill co-operative in his village and the remainder is generated by burning natural gas (assume 100% methane). The farmer drives 3000 kilometres per year, in a petrol-fuelled truck (assume fuel is 100% pentane) with a mileage of 30 kilometres/litre, collecting pig-feed and delivering his pigs to market. If burning methane generates 55 MJ of energy per kg, how much CO₂ does the farmer's pig-production operation contribute to the atmosphere per year? The density of pentane is 626 kg m⁻³.

- Q.2 With reference to thermal comfort assessment, explain the term *Predicted Mean Vote*.

Calculate the contact temperature between a bare foot at 30°C and a concrete floor at 22 °C if the contact coefficients ("b-values") for concrete and skin are 1680 J m⁻² K⁻¹ s^{-1/2} and 1120 Jm⁻² K⁻¹ s^{-1/2}, respectively).

Continued.....

Briefly explain two of the following statements:

- (a) atmospheric ozone concentrations are influenced by methyl bromide usage in agriculture
- (b) the ozone hole over the Antarctic is larger during the polar spring than during other seasons of the year
- (c) anthropogenic sulphate aerosol may influence global atmospheric temperature variations

- Q.3 Describe the principles of operation (noting how the performance of each system is defined) of the following: heat pump, refrigerator, heat engine.

What is the maximum efficiency of a steam engine that takes in steam at 100°C and exhausts it at 27°C ?

Briefly explain how the third law of thermodynamics limits the efficiency of a steam engine.

SECTION B

- Q.4 With reference to the nuclear fuel cycle, explain what you understand by the terms *enrichment*, and *re-processing*. What is the role of the following in a nuclear reactor: control rod, moderator, coolant? Of what materials are control rods commonly composed?

Describe, using a diagram, the operation of a gamma ray sterilisation plant. What are the advantages/disadvantages of this technique compared to other sterilisation methods?

- Q.5
- (a) Describe beta particle emission and outline some of their properties.
 - (b) Outline the correct way to construct shielding for a strong beta source.
 - (c) The columnar range of the beta particles from phosphorous-32 (^{32}P) in any material is 800 mg cm^{-2} . Calculate the range in air, water and aluminium of these betas.
 - (d) An end window Geiger counter (window area = 5 cm^2) records a count rate of 200 cps in a beam of beta particles from strontium-90. Calculate the dose rate to your skin, placed in the beam, given that for ^{90}Sr the dose rate is 110 microsievert/hr for $100 \text{ betas.cm}^{-2}.\text{s}^{-1}$.
 - (e) Outline one industrial application for beta particle sources.
[Densities; water = 1.0 g cm^{-3} , air = 0.0013 g cm^{-3} , aluminium = 2.7 g cm^{-3}]