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OLLSCOILE NA hÉIREANN
GAILLIMH

NATIONAL UNIVERSITY OF IRELAND
GALWAY

SUMMER EXAMINATIONS 2000

B.Sc. (Honours) Applied Physics and Electronics: Paper 3

EP416: Radiation, Environment & Medical Physics

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Time Allowed: TWO hours	Answer THREE questions

Q.1 Answer three of the following parts:

(a) Outline the radon problem and discuss its remediation.
(b) Using a diagram describe the operation of a gamma ray sterilisation plant.
(c) Derive the equation for the dose rate to an organ from an internal evenly distributed gamma ray isotope, clearly defining the parameters used.
(d) Describe the technique of transaxial emission computerised tomography (ECT) as used in nuclear medicine.

Q.2 Answer all the following questions relating to nuclear medicine imaging.

(a) A radioisotope is cleared from an organ by the combined processes of physical decay and biological clearance. If both of these processes follow exponential decay, prove that the effective half life T_{eff} is given by the equation;

$$1/T_{eff} = 1/T_{phys} + 1/T_{biol}$$

(b) Describe qualitatively how patient scatter effects the nuclear image. Show how its effects may largely be eliminated.
(c) Describe four types of collimators used with a gamma camera giving their important properties. What is meant by intrinsic resolution, collimator resolution and system resolution and state how they are related.
(d) Outline the technique of positron emission tomography (PET).

p.t.o.

Q.3 Answer all parts.

(a) Describe and discuss at least five factors which would effect the radiation dose to a patient in diagnostic radiology.

(b) What effect does scatter have on image quality in x-ray imaging? Describe two measures to reduce scatter.

(c) The filament of a x-ray tube is 15 mm long and 1.5 mm wide. The focal spot of the x-ray tube is 1.5 mm x 1.5 mm. Describe how this is achieved, giving numerical calculations.

Q.4 With respect to airborne matter in the environment, explain the following terms:
isometric particle, mean free path of an air molecule, diffusion coefficient, aerodynamic diameter, and slip correction factor.

Show how Reynold's number provides a benchmark to determine whether fluid flow is laminar or turbulent.

Determine the critical value of flow velocity in a pipe of diameter 10 cm, below which the air flow is deemed to be laminar. You can assume that the upper limit of Reynold's number for laminar flow in a pipe is 2100.

Density of air = $1.20\ kg\ m^{-3}$
Viscosity of air = $1.8 \times 10^{-5}\ kg\ m^{-1}\ s^{-1}$

Q.5 Explain what is meant by the following quantities: mechanical mobility, relaxation time, stop distance, Stokes number, class 100 clean room.

Consider an aerosol particle that is released with zero initial velocity in still air. Show that its velocity u(t), at time t is given by the relation

$$u(t) = u_\infty (1 - e^{-t/\tau})$$

where u_∞ is the terminal fall velocity of the particle and τ is the relaxation time.

Calculate the time required for an aerosol particle of density $10^3\ kg\ m^{-3}$, and of diameter 10 μm to reach terminal velocity, when released in still air of dynamic viscosity equal to $1.8 \times 10^{-5}\ kg\ m^{-1}\ s^{-1}$.