D3APH2304 (2 Pages) Name............................

Reg.No..........................

THIRD SEMESTER M. Sc. DEGREE EXAMINATION, NOVEMBER 2024
(Regular/Improvement/Supplementary)
PHYSICS
FPHY3E03: RADIATION PHYSICS

Time: 3 Hours **Maximum Weightage: 30**

Part A: Short answer questions. Answer *all* questions. Each carries *one* weightage.

1. Suggest a suitable radiation source for conducting a Rutherford backscattering experiment and explain the basic principle.
2. For an experiment one require intense X-rays of a wide range of wavelengths. What is a suitable source and why it is suitable?
3. Explain the interaction of the following radiations with a thick graphite block by giving a schematic of beam profiles. (a) 1 MeV gold *Vs* 1 keV gold; and (b) 1 keV electron beam.
4. Discuss the concept of ALARA with the main features.
5. A beam of 10^{14} protons in one second in one cm^2 area has been exposed for 10 minutes on a sample for an ion irradiation experiment. Calculate ion flux and fluence.
6. An absorbed dose of 0.5 Gy of helium beam is more harmful to human tissue than the same amount of absorbed dose of γ-ray radiation. Justify the statement.
7. Compare linear energy transfer (LET) and the relative biological effectiveness (RBE) of radiation.
8. Compare Compton scattering *Vs* Pair production.

(8 × 1 = 8 weightage)

Part B: Essay questions. Answer any *two* questions. Each carries *five* weightage.

9. Explain of the basic principle and working of: (a) three fast electron sources; (b) one source for γ-ray.
10. Give a detailed discussion of energy-loss mechanisms, stopping power, and range when a beam of energetic: (a) heavy charged particle; and (b) electrons interact with a solid.
11. Explain the principle and working of: (a) solid dosimeters (TLD and RPL); and (b) any three area survey meters, with schematic diagrams.
12. (a) Give a detailed explanation of the genetic effects of ionizing radiation on biological systems.

    (b) Briefly explain the physics behind the precautions to be taken and radiation shielding while handling the source and experiments using neutrons.

(2 × 5 = 10 weightage)

(P.T.O.)

Part C: Problems. Answer any *four* questions. Each carries *three* weightage.

13. It was found that 15.1% of the naturally occurring samarium (^{147}Sm) is radioactive and decays by alpha emission. One gram of natural Sm gives 89 decays per second. Calculate the half-life of the isotope ^{147}Sm.
14. X-ray photons of energy of 300 keV scatter on a target, if the scattered X-rays were detected at 30◦ relative to the incident X-rays, determine the Compton shift at this angle and the energy of the recoiling electron.
15. A person working in mining industry has been exposed to 1 mGy of γ-rays, 0.4 mGy of neutrons in a week time. Calculate the total equivalent dose of this person (the quality factors for γ-rays and neutrons are 1, 5 respectively).
16. The intensity of an unshielded Cs-137 source is 1 R/hr. If the source is put into a lead shield of 5 cm thick, Calculate the intensity at the outside of the shield?
    (Density of lead = 11.35 gm/cc, mass attenuation coefficient = 114 cm^2/Kg).
17. If a beam of 2 MeV proton travel 10 microns inside a substrate and lose 1 MeV energy. Estimate the nuclear energy loss in eV/nm if the electronic energy loss is 50 eV/nm.
18. Calculate the KERMA if the photon flux is 10^{16}/m^2, photon energy 10 MeV, linear attenuation coefficient 0.028 cm^2/g and energy transfer attenuation coefficient 0.022 cm^2/g.
19. Estimate the dose received by a person who spends one minute at 2 m from an unshielded 100 Ci source of ^{192} Ir . (Γ= 0.5 R m^2 /hr/Ci).

(4 × 3 = 12 weightage)