國 立 清 華 大 學 命 題 紙

97 學年度 核子工程與科學研究 所 甲(工程) 組碩士班入學考試

科目 核工原理 科目代碼 3102 共 1 頁第 1 頁 *請在【答案卷卡】內作答

解釋名詞： (30%; each 3%)

(1) Bremsstrahlung
(2) Auger electron
(3) Bragg curve
(4) LET
(5) thermal disadvantage factor
(6) neutron age
(7) spatial self-shielding
(8) specific burnup
(9) delayed critical
(10) prompt jump approximation

計算與證明題： (70%)

1. For the $^{218}_{84}\mathrm{Po} - ^{214}_{82}\mathrm{Pb}$ system and starting with freshly-separated $^{218}_{84}\mathrm{Po}$, determine how long will it take for equal amounts of the two species to exist? The half-lives of $^{218}_{84}\mathrm{Po}$ and $^{214}_{82}\mathrm{Pb}$ are given by 3.05 min and 26.8 min, respectively. (8%)

2. Show that the minimum energy of the scattered photon after making a Compton scattering collision is given by

$$E'_{\min} = \frac{EE_e}{2E + E_e},$$

where E and E_e denote incident-photon and electron rest-mass energies, respectively. (6%)

3. Assume the pair-production cross section (σ_{pp}) of $^{208}_{82}\mathrm{Pb}$ at 1.98 MeV is 1 b. Estimate σ_{pp} at 10 MeV for $^{238}_{92}\mathrm{U}$. Also The photoelectric cross section (σ_{pe}) of $^{208}_{82}\mathrm{Pb}$ at 0.6 MeV is approximately 18 b. Estimate σ_{pe} at this energy for uranium. (8%)

4. When a 2 MeV neutron scatters from an $^{16}_{8}\mathrm{O}$ atom. Determine the total change in lethargy and the average number of scattering collisions that the neutron is made before its speed reaches 2200 m/s. The neutron mass is 1.008665 amu and amu is given by 1.6605×10^{-27} kg. (6%)

5. Compare the effective multiplication factor (four-factor formula) of heterogeneous reactors with that of homogeneous reactors. Describe the reasons for causing such difference. (10%)

6. Determine the critical radius of a bare, 120 cm high cylindrical reactor containing the following data: (10%)
$\Sigma_a = 0.082\ \mathrm{cm}^{-1}$, $\Sigma_{tr} = 0.342\ \mathrm{cm}^{-1}$, $\nu\Sigma_f = 0.0843\ \mathrm{cm}^{-1}$, $\Sigma_f = 0.03413\ \mathrm{cm}^{-1}$, $\rho = 19\ \mathrm{g/cm}^3$.

7. Consider a point source emitting S_o thermal neutrons/sec located at the origin in an infinite homogeneous and diffusing medium. Determine the average distance that a thermal neutron travels from its source point to the point where it is absorbed. (10%)

8. A sphere of non-multiplying moderator of radius R, containing uniformly distributed sources of $S(r) = S_o$ neutrons/cm^3-sec, is placed in an infinite vacuum. What is the probability that a neutron emitted by the source will be absorbed in the sphere? (12%)