

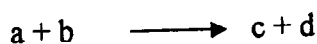
國立清華大學命題紙

99 學年度 核子工程與科學研究所工程組 碩士班入學考試

科目 核工原理 科目代碼 2902 共 2 頁第 1 頁 *請在【答案卷卡】內作答

1. Gold-198 has a half life of 60 hours and can be produced by bombarding stable Gold-197 with neutrons in a nuclear reactor. A Gold-197 foil is placed into a reactor for 20 hours and its activity is 1 Ci when removed; (a) what is the theoretical maximum activity due to Gold-198 in the gold foil (b) how long does it take for the activity to reach 80% of the maximum activity? (15%)

2. (a) Derive the relation between binding energy and the Q value for the following nuclear reaction :



- (b) What is the difference between fission and fissionable but non-fissile material in terms of critical energy and binding energy?

- (c) Plot the fission cross section versus energy for U-235 and U-238 and explain your plot. (15%)

3. The thermal absorption cross section for U-235 and U-238 are 680 b and 3b respectively. What is the thermal macroscopic absorption cross section for 10 % w/o enriched UO_2 . Assume the absorption cross section for oxygen is 0b; UO_2 has a density of 10 g/cm^3 ; the atomic weight for U-235 and U-238 are 235 and 238 respectively. (10%)

4. (a) What is the relation between thermal group flux and thermal neutron (velocity = 2200m/s) flux? (b) What is the relation between linear doubling time and exponential doubling time?

- (c) Whether thorium-uranium cycle or plutonium-uranium cycle can be used for a thermal breeder reactor and why? (15%)

5. Three isotropic point sources, each emitting S_0 neutrons/sec, are located at the three corners of an equilateral triangle of side a in an infinite vacuum. Find the flux ϕ and current \vec{J} at the midpoint of one side. (10%)

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6. A sphere of moderator of radius R contains a uniformly distributed source emitting $S(r) = S_0$ neutrons/cm³-sec. The medium surrounding the spherical moderator is an infinite vacuum. The diffusion length of the moderator is L , the diffusion coefficient is D , and the extrapolated distance is d . Find the probability that a neutron emitted by the source will be absorbed in the sphere. (20%)

7. The Table shown below presents two-group cross sections for a bare, multiplying, spherical reactor core of radius $R = 50$ cm. Neglect the extrapolated distance d , and assume there is no upscattering and all fission neutrons are born in the fast energy group. Determine each term of the effective multiplication factor.

| Group | Σ_a (cm ⁻¹) | $\nu\Sigma_f$ (cm ⁻¹) | Σ_{tr} (cm ⁻¹) | $\Sigma_{s1\rightarrow2}$ (cm ⁻¹) |
|-------------|--------------------------------|-----------------------------------|-----------------------------------|---|
| fast (1) | 0.015 | 0.004 | 0.222 | 0.055 |
| thermal (2) | 0.12 | 0.153 | 0.666 | ---- |

where $\Sigma_{s1\rightarrow2}$ denotes the scattering cross section for neutrons scattering out of the fast group (group 1) into the thermal group (group 2).

(15%)