九十三學年度 工程與系統科學 系（所） 丙 組碩士班入學考試

科目 核工原理 科號 4003 共 兩 頁第 一 頁 *請在試卷【答案卷】內作答

Nomenclature（解釋名詞）：(20%, each 5%)

1. Auger electron
2. Ceronkov radiation
3. thermal disadvantage factor
4. spatially self-shielding

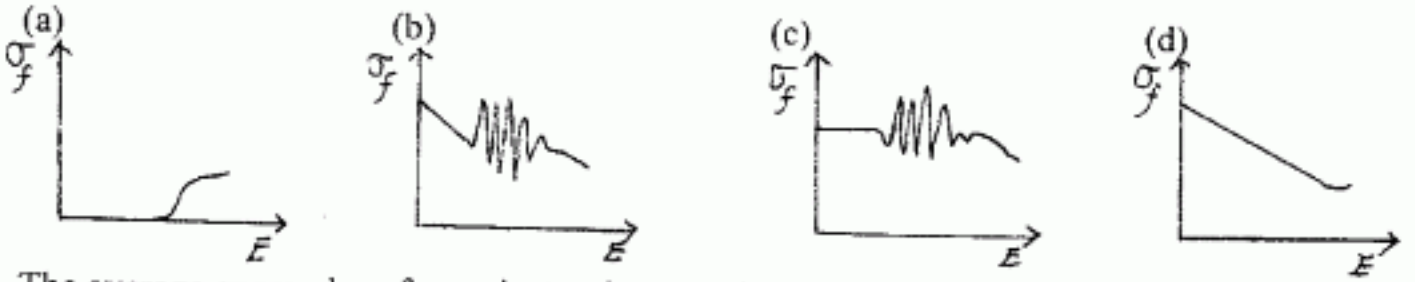
Multiple choices（單選題）：(40%, each 4%)

1. The wavelengths of 1 MeV electron, neutron, and photon are given by λ_e, λ_n, and λ_γ, respectively. Which statement is correct?
(a) $\lambda_e = 0.124$ nm, (b) $\lambda_n = 0.00286$ nm, (c) $\lambda_\gamma = 1.44$ nm, (d) none of above.

   Note: Planck's constant h = 6.6256×10^{-34} joule-sec; amu = 1.6605×10^{-27} kg, eV = 1.6021×10^{-19} joule; m_e = 0.000549 amu; m_n = 1.008665 amu

2. For a nucleus ${}_ZX^A$ to proceed positron decay, which statement is correct? Note: M and m denote the atomic and nuclear masses, respectively.
(a) $M_{Z,A} > M_{Z-1,A} + 2m_e$, (b) $M_{Z,A} > M_{Z-1,A}$, (c) $m_{Z,A} > m_{Z-1,A} + m_e$, (d) none of above.

3. Regarding to the fission cross section (σ_f) of ${}_{92}U^{233}$ versus neutron energy (E), which figure is correct?



4. The average energy loss for an isotropic scattering of an incident neutronwith a target nucleus (mass number = A) is given by $\overline{\Delta E} = \frac{1}{2}(1-\alpha)E_0$, where E_0 is the kinetic energy of the neutron before collision and α represents the collision parameter $[(A-1)/(A+1)]^2$. Now if the scattering is forward peaking (i.e., favors small-angle scattering), which statement is correct? Briefly explain why?

5. From the moderator data gieven as below;

cross section (b)	H	D	O
σ_s	49.4	4.7	4.2
σ_a	0.33	0.0005	0

The mass densities of H_2O and D_2O are 1.0 and 1.1 g/cm^3, respectively. Compare the properties of H_2O and D_2O in slowing down 2 MeV neutrons to thermal energy, whcih statement is correct? Briefly explain why?
(a) H_2O has a smaller lethargy gain per elastic scattering collision, (b) H_2O has a smaller moderation power, (c) H_2O has a smaller moderating (effectiveness) ratio, (d) H_2O needs to make more elastic scattering collisions with neutrons.

6. Regarding to the mass attenuation coefficient (μ/ρ) of $_{13}Al^{27}$ and $_{26}Fe^{58}$ for 1.5 MeV γ-rays, which statement is correct? Briefly explain why?
(a) $(\mu/\rho)_{Al} >> (\mu/\rho)_{Fe}$, (b) $(\mu/\rho)_{Al} \approx (\mu/\rho)_{Fe}$, (c) $(\mu/\rho)_{Al} << (\mu/\rho)_{Fe}$, (d) none of above.

7. Regarding specific ionization I_s, which statement is correct?
(a) same M, charge ↑ => I_s ↓, (b) same E, mass ↑ => I_s ↓, (c) same E, mass ↑ => I_s ↑, (d) none of above.

8. Regarding to thermal flux (ϕ_T) and 2200 meters-per-second flux (ϕ_0), which statement is correct? Briefly explain why?
(a) $\phi_T = N_0 v_{ave}$, (b) ϕ_T is a flux assuming all the thermal neutrons at 20°C, (c) ϕ_0 is a flux assuming all the thermal neutrons possess energies ranging from 0 to $5kT_n$, (d) none of above.

9. Regarding to the four-factor formula for heterogeneous reactors, which statement is correct? Briefly explain why?
(a) $\eta_{hetero} > \eta_{homo}$, (b) $\varepsilon_{hetero} < \varepsilon_{homo}$, (c) $p_{hetero} = p_{homo}$, (d) $f_{hetero} < f_{homo}$.

10. Regarding time-dependent reactors, which statement is correct? Note that k, ρ, and β denote multiplication factor, reactivity, and delayed-neutron fraction, respectively.
(a) if $k = 1.002$, ρ = 20 pcm, (b) β = 0.065 for U-235, (c) if $k = 1.003$, ρ = 0.482$, (d) none of above.

Calculations（計算與證明題）：(40%, each 10%)

1. The measured lifetimes ($T = 1/\lambda$) of $_{92}U^{235}$ and $_{92}U^{238}$ are 1.02×10^9 years and 6.52×10^9 years, respectively. Assume they were equally abundant when the uranium in the earth was originally formed. From the natural uranium normally found on the earth at the present time, estimate how much time has elapsed since the time of formation.

2. Derive the neutron spectrum in the epi-thermal energy region is proportional to 1/E.
Hint: You may assume that absorption is negligible in this case.

3. Derive the one-group critical (criticality) equation for a bare reactor.

4. Given a two-group, bare, very large reactor containing the data listed below. Assume there is no up-scattering and all fission neutrons are born in the fast energy group. Determine the multiplication factor of the reactor.

Group	$\nu\Sigma_f$ (cm^{-1})	Σ_f (cm^{-1})	Σ_a (cm^{-1})	D (cm)	$\Sigma_{s1\to2}$ (cm^{-1})
fast (1)	0.008476	0.00332	0.01207	1.2627	0.02619
thermal (2)	0.18514	0.07537	0.121	0.3543	------

where $\Sigma_{s1\to2}$ denotes the macroscopic scattering cross section for scattering the neutrons from the fast group into the thermal group.