List of typical questions for comprehensive test 1

1. What is the source of the binding energy of the nucleus? How can you calculate ir? What is the specific binding energy (binding energy related to the mass number) of the most stable nuclei?
2. Show how the specific binding energy (binding energy related to the mass number) changes with the mass number. Based on the curve show why the nuclear fission reactions can be used for energy production.
3. Show how the specific binding energy (binding energy related to the mass number) changes with the mass number. Based on the curve show how the nuclear fusion reactions could be used for energy production.
4. What are the most frequent types of radioactive decay?
5. Describe the main features of alpha decay
6. Describe the main features of beta decays
7. Describe the main features of isomeric transition
8. Characterize the mean features of alpha radiation.
9. Characterize the mean features of beta radiations.
10. Characterize the mean features of gamma radiation.
11. What do you know about the interaction between alpha radiation and matter?
12. What do you know about the interaction between beta radiations and matter?
13. What dou you know about positrons and their interactions.
14. What do you know about the interaction between gamma radiation and matter?
15. Compare the LET curves of electron and alpha radiation.
16. $^{239}_{94}Pu$ stabilizes with alpha decay of a half life 24100 years. The energy of the alpha particles is 5.157 MeV.
a) what will be the product of the decay?
b) what is the total energy released by 24 mg $^{239}_{94}Pu$ during 1 year.
17. Define the linear absorption coefficient. What are the main contibuting factors and what is its dimension or give a possible unit?
18. What are the most typical mechanisms of gamma - matter interactions?
19. Why is it not suggested to use high Z materials in the protection against beta radiations?
20. From the point of view of origin and characteristics, compare braking and characteristic X-ray radiation.
21. Describe the operation principle of the Geiger-Müller counters.
22. Describe the operation principle of the scintillation counters.
23. What kind of scintillator materials do you know?
24. What is the role of the photomultiplyer in a scintillation detector?
25. Describe the operation principle of semiconductor detectors.
26. Describe the positron annihilation process.
27. The change of the activity during an activation process
28. In the modern technologies the centrifugal separation of gaseous UF_6 is one of the main step of the enrichment of the various isotopes of uranium.
a) Calculate the activity of 200 kg UF_6 gas, supposing that it contains only ^{235}U .
b) The half-life of ^{235}U is $7.038 \cdot 10^8$ year. How long does it take to reduce the activity by 10 %?
29. ^{60}Co isotopes (half-life 1925 days) are often used in anticancer medical therapies.

a) How much was the activity of a ^{60}Co when it was purchased 2 years ago, if now its activity is 5 MBq.

30. Uranium is obtained from U_3O_8. The half-life of ^{238}U is $4.5 \cdot 10^9$ year. Calculate the activity of 750 mg U_3O_8, if we suppose that it contains only this isotope of uranium.

Further questions supporting the preparation for TEST1:

1. Name the main building blocks of the nucleus
2. Estimate the ratio of the diameter of a nucleus and an atom
3. What is the relationship between mass and energy? (Explain the symbols).
4. Compare the energies equivalent to the mass of a proton, a neutron and an electron.
5. Compare the charge of the proton, the neutron and the electron.
6. Define the mass number of a nucleus
7. Estimate is the atomic mass related energy of the most stable nuclei.
8. The nuclides having identical number of protons are called ….
9. What is the main source of the isotope effect?
10. Define the radiactivity phenomenon
11. Write the scheme of the isomeric transition. Explain the symbols.
12. Write the scheme of the β^- decay. Explain the symbols.
13. Write the scheme of the β^+ decay. Explain the symbols.
14. Write the scheme of the electron capture. Explain the symbols.
15. Write the scheme of the alpha decay. Explain the symbols.
16. Characterize the energy distribution of the β^- particles.
17. Characterize the energy distribution of the β^+ particles.
18. Characterize the energy distribution of the α particles.
19. What are the typical features of the γ photons?
20. What are the typical features of the α particles ?
21. What are the typical features of the β^- particles ?
22. What are the typical features of the β^+ particles ?
23. Compare the properties of the electron and the positron.
24. Describe the process called positron annihilation.
25. Why characteristic X-rays are emitted when electron capture occurs ?
26. What are the typical features of the characteristic X-rays radiation?
27. The unit eV is used to express the energy involved in nuclear transitions. 1 eV= 1.6×10^{-19} J. The energy released during the β^- decay of ^3H is 0.018 MeV. Compare this to a H-H bond (the bond energy is 436 kJ/mol).
28. Define the rate of radioactive decay.
29. What are the present and former units of radioactivity? What is their relationship?
30. What is the physical meaning of the half-life of a radioactive nucleus?
31. What is the relationship between the measured intensity and the activity?
32. What defines the rate of decay of the daughter element?
33. Explain the peculiarities of the decay of $_{90}Sr$.
34. Explain the peculiarities of the decay of $_{226}Ra$.
35. Give the scheme of the set-up used for measuring the absorption of nuclear radiation.
36. Define the linear absorption coefficient. What is the physical meaning of the halfthickness?

37. What are the mechanisms of α - matter interactions?

38. What is the braking radiation (Bremsstrahlung) and when does it occur?

39. What are the mechanisms of β - matter interactions?

40. Show the *I*-*x* dependence for α-radiation.

41. Show the *I*-*x* dependence for β-radiation.

42. What are the mechanisms of γ - matter interaction?

43. Describe the Compton-scattering (including Z and E_γ dependence).

44. Describe the photoelectric effect. (including Z and E_γ dependence).

45. Describe the pair production. (including Z and E_γ dependence).

46. Show the overall E_γ - Z dependence of γ interactions.

47. Show the σ - E function of a (n,γ) reaction.

48. Show the σ - E function of an (γ,n) reaction.

49. Write the simplified formula for the ^{12}C+d $\rightarrow$ ^{13}N+n nuclear reaction.

50. Show how the activity achieved in a nuclear reaction depends on the time of irradiation.

51. What are the factors defining the maximum achievable activity?

52. Give the formula how the activity can be calculated after „t” irradiation and a „t_h” decay interval?