

## Homework: Ch. 31 & 32

1. What is the radius of an  $\alpha$  particle?
2. Show that if you assume the average nucleus is spherical with a radius  $r = r_0 A^{1/3}$ , and with a mass of  $Au$ , then its density is independent of  $A$ .
3. What is the kinetic energy in MeV of a  $\beta$  ray that is traveling at  $0.998c$ ? This gives some idea of how energetic a  $\beta$  ray must be to travel at nearly the same speed as a  $\gamma$  ray.
4. A  $^{60}\text{Co}$  source is labeled  $4.00 \text{ mCi}$ , but its present activity is found to be  $1.85 \times 10^7 \text{ Bq}$ .
  - a. What is the present activity in mCi?
  - b. How long ago did it actually have a  $4.00 \text{ mCi}$  activity? The half-life of  $^{60}\text{Co}$  is  $5.2714 \text{ years}$ .
5. The ceramic glaze on a red-orange Fiesta ware plate is  $\text{U}_2\text{O}_3$  and contains  $50.0 \text{ grams}$  of  $^{238}\text{U}$ , but very little  $^{235}\text{U}$ . What is the activity of the plate?
6. The fact that  $BE/A$  is greatest for  $A$  near  $60$  implies that the range of the nuclear force is about the diameter of such nuclides.
  - a. Calculate the diameter of an  $A = 60$  nucleus.
  - b. Calculate  $BE/A$  for  $^{58}\text{Ni}$ , which is a tightly bound nuclide.
7. A neutron generator uses an  $\alpha$  source, such as radium, to bombard beryllium, inducing the reaction  $^4\text{He} + ^9\text{Be} \rightarrow ^{12}\text{C} + n$ . Calculate the energy output of the reaction in MeV.
8. A plumber at a nuclear power plant receives a whole-body dose of  $30 \text{ mSv}$  in  $15 \text{ minutes}$  while repairing a crucial valve. Find the radiation-induced yearly risk of death from cancer.
9. In the 1980s, the term picowave was used to describe food irradiation in order to overcome public resistance by playing on the well-known safety of microwave radiation. Find the energy in MeV of a photon having a wavelength of a picometer.
10. Tritium is naturally rare, but can be produced by the reaction  $n + ^2\text{H} \rightarrow ^3\text{H} + \gamma$ . How much energy in MeV is released in this neutron capture?

11. The electrical power output of a large nuclear reactor facility is 900 MW. It has a 35.0% efficiency in converting nuclear power to electrical.
- What is the thermal nuclear power output in megawatts?
  - How many  $^{235}\text{U}$  nuclei fission each second, assuming the average fission produces 200 MeV?
  - What mass of  $^{235}\text{U}$  is fissioned in one year of full-power operation?