# 國立清華大學
# ESS 201000 核工原理
# (Principle of Nuclear Engineering)

## Homework #1

1. Using the data given next and in Example 2.2, compute the molecular weights of
(a) $H_2$ gas,
(b) $H_2O$,
(c) $H_2O_2$.

| Isotope | Abundance, *a/o* | Atomic weight |
|---|---|---|
| $^1H$ | 99.985 | 1.007825 |
| $^2H$ | 0.015 | 2.01410 |

2. When $H_2$ gas is formed naturally occurring hydrogen, what percentages of the molecules have molecular weights of approximately 2, 3, and 4?

3. The planet earth has a mass of approximately $6\times10^{24}$ kg. If the density of the earth were equal to that of nuclei, how big would the earth be?

4. An electron starting from rest is accelerated across a potential difference of 5 million volts.
(a) What is its final kinetic energy?
(b) What is its total energy?
(c) What is its final mass?

5. Using the result derived in Problem 2.20, calculate the speed of a 1-MeV electron, one with a kinetic energy of 1 MeV.

6. According to Eq. (2.20), a photon carries momentum, thus a free atom or nucleus recoils when it emits a photon. The energy of the photon is therefore actually less than the available transition energy (energy between states) by an amount equal to the recoil energy of the radiating system.

(a) Given that $E$ is the energy between two states and $E_\gamma$ is the energy of the emitted photon, show that

$$E_\gamma \simeq E\left(1 - \frac{E}{2Mc^2}\right)$$

where $M$ is the mass of the atom or nucleus.

(b) Compute E- $E_\gamma$ for the transitions from the first excited state of atomic hydrogen at 10.19 eV to ground and the first excited state of $^{12}$C at 4.43 MeV to ground (see Figs. 2.2 and 2.3).

7. Using the chart of the nuclides, complete the following reactions. If a daughter nucleus is also radioactive, indicate the complete decay chain.

(a) $^{18}$N→

(b) $^{83}$Y→

(c) $^{135}$Sb→

(d) $^{219}$Rn→

8. Tritiated water (ordinary water containing some $^{1}H^{3}HO$) for biological applications can be purchased in1-cm$^3$ ampoules having an activity of 5 mCi per cm$^3$. What fraction of the water molecules contains a $^3$H atom?

9. One gram of $^{226}$Ra is placed in a sealed, evacuated capsule 1.2 cm$^3$ in volume.

(a) At what rate does the helium pressure increase in the capsule, assuming all of the α-particles are neutralized and retained in the free volume of the capsule?

(b) What is the pressure 10 years after the capsule is sealed?