# Intro HP Problem Set 1 | Part 1A Radioactive Material & Radioactivity

### Math Review (optional but recommended)

1. Write down the following in scientific notation:
   1. 100,098 = 1.00098 X 10^5
   2. 0.00345 = 3.45 X 10^-3
   3. E = X 10^
2. Calculate the numerical product of Avogadro’s number and the nuclear diameter in scientific notation and ordinary notation.

6.023 X 10^23 \* 3.36 femtometers = 20.237 X 10^23 moles\*femtometers/g

1. If X is equal to 0.89 and Y is an angle of 30º, what is the following quotient?

Y = 0.52 radians

1.5 / (0.5\*0.246) = 12.15

X-3.5/ 0.5 (sin Y)2

1. A voltmeter has a meter face with 20 scale divisions covering the range 0 to 2 volts. What is the largest number of significant figures that would be justified in reading this meter? 2/20 = 0.1 volts so 2 significant figures (e.g., 0.5 or 1.3)
2. What units would properly result from the quotient of ((R-m)/(mA-sec)) by ((V/sec) X (1/R))? Only the seconds term cancels out
3. Find t if 2.4 et = 8.0.
   1. T = 2.079/0.875 = 2.37
   2. T = ln(8.0)/ln(2.4) = 2.37
4. If 2.47E2 = x to the 4th power, find x. x = ln(2.47)/4 = 1.37

### Problems

1. Compute the nuclear radii of:
2. b) c) d)
3. R = 1.2\*((atomic number)^(1/3))
4. A= 1.2, b=1.73, c=6.09, d=7.4
5. Find the number of atoms in 0.006kg of lead, atomic weight 207
   1. 0.006 kg \* 1000 (g/kg) \* (mole/207g) \* 6.023E23 atoms/mol = 1.8E22 atoms
6. Find the gram molecular weight (mole) of sulfuric acid, H2SO4. The atomic weights are: H – 1.00, S – 32.06, O – 16.00. 98.06 grams/mole
7. Find the mass in kilograms of a single atom of thorium, atomic weight 232.
   1. 232 g/mole \* (1 mole/6.023E23 atoms) \* (1 kg/1000 g) = 3.85E-25 kg
8. The mass of a 12C atom is experimentally found to be 19.92637x10-27 kg. Assuming the carbon nucleus to be spherical, compute the nuclear density of .
   1. Density (p) = mass/volume
      1. Mass = 19.92637x10-27 kg
   2. R (radius) = R0 \* A^(1/3) = 1.2x10^-15 \* 12^(1/3) = 2.74 x 10^-15
      1. A = 12 (Carbon)
   3. Volume = 4/3 \* 3.1416 \* R^3 where R=2.74 x 10^-15; V=8.68x10^-44 m3
   4. Density = mass/volume = 19.92637x10-27 kg / 8.68x10^-44 m3 = 2.29 x 10^17
9. Find the value of Avogadro’s number using the mass of given above (#12) and the definition of unified mass unit. ???
10. If the number of radioactive atoms at time t is 2x106, and 2x104 atoms disintegrate in 5 minutes, what is the approximate radioactive constant?
    1. ln(2x10^4/2x10^6)/-5 min = 0.92/min
11. If the radioactive constant is 0.1/day and there are 3x106 radioactive atoms, approximately how many atoms will disintegrate in 1 minute?
    1. At = (3x10^6) \* exp(-0.1/day\*(day/24 hours)\*(hr/60mins)\*1 min) = 2999792 atoms
12. From the formula , find the activity of a sample at 4:00pm when its activity was 1000 disintegrations per minute at 10:00 AM. The decay constant (λ) of the sample is 0.2/day.
    1. At = 951 dis/min
    2. At = 1000 dis/min \* exp(-0.2/day\*(1/24)\*(1/60)\*6hrs\*60min/hr)
13. The half-life of radon is 3.8235 days. What is the decay constant?
    1. Lambda = ln(2) / T1/2 = 0.693 / 3.8235 days = .182 /days
14. The activity of 10-7 kg of 230Th is found to be 7.2x104 Bq (dis/s). What is the half life of ?
    1. 10^-7 kg \* (1000 g/kg) \* (mol/230g) = 4.34\*10^-7 mol \* 6.023x10^23 atoms/mol = 2.618X10^17 atoms = N
    2. Lamda = A/N = 7.2x10^4 Bq / 2.618x10^17 atoms = 2.75 X 10^-13 /sec
    3. T1/2 = ln(2)/lambda = 0.693/2.75 X 10^-13 /sec = 2.519x10^12 /sec

### Crosswalk

* Math Review
  + 1 – 7 = Gollnick 1 Problem Set #1-7 (pg. 25)
* Problems
  + 8 – 13 = Moe Section 1 # 1-4, 6, 7
  + 14 – 18 =Moe Section 2 # 2-5, 7