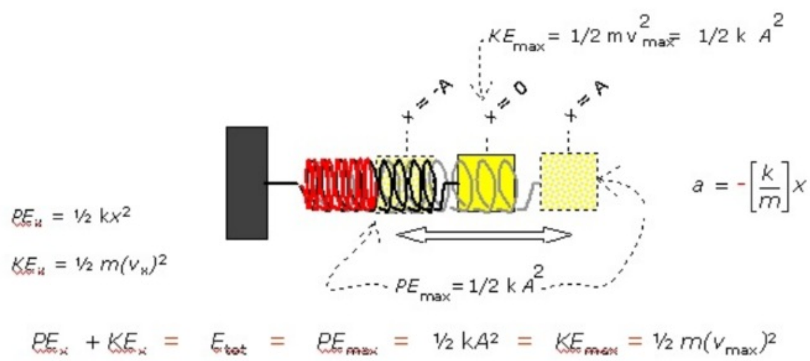
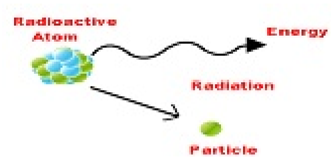
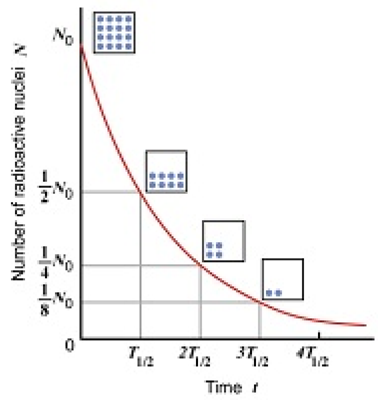
Physics 2204
Unit 3: Work, Power and Energy
Study Guide 2

Simple Harmonic Motion	is periodic motion in the absence of friction and produced by a restoring force that is directly proportional to the displacement and oppositely directed. To calculate acceleration : $\vec{a} = -\frac{k\vec{x}}{m}$  Acceleration is always opposite to displacement.
PROTON (+)	Positively charged particles Help make up the nucleus of the atom Help identify the atom (could be considered an atom's DNA) Equal to the atomic number of the atom Contribute to the atomic mass Equal to the number of electrons $m_p = 1.67262 \times 10^{-27}$ kg
NEUTRON	Neutral particles; have no electric charge Help make up the nucleus of the atom Contribute to the atomic mass $m_n = 1.67493 \times 10^{-27}$ kg
ELECTRON	Negatively charged particles Found outside the nucleus of the atom, in the electron Move so rapidly around the nucleus that they create an electron cloud Mass is insignificant when compared to protons and neutrons Equal to the number of protons Involved in the formation of chemical bonds $m_e = 9.1164 \times 10^{-31}$ kg

Nucleons	particles which make up the nucleus, namely protons and neutrons. **#of Neutrons = Atomic Number(A) -Atomic Mass Z**
Atomic number (Z)	number of protons (or electrons in an atom)
Atomic mass number (A)	-number of nucleons (protons + neutrons).
Isotopes	atoms of the same element (same Z) but having differing numbers of neutrons and thus differing atomic mass (differing A).
Radioactivity - .	the spontaneous disintegration of atomic nuclei through the emission of radiation or particles. Unstable nuclei change to more stable nuclei by releasing emissions.In some instances, a new element is formed and in other cases, a new form of the original element, called an isotope, appears 
Transmutations -	to the changing of one element into another by the process of radioactivity. Particles or energy might be emitted from a parent nucleus resulting in a new element called a daughter nucleus which itself might be unstable and subsequently emit more particles or energy.
Types of Natural Transmutation:	***1) Alpha decay (α)*** General eq'n: $^{A}_{Z}X \rightarrow ^{A}_{Z+1}Y + ^{0}_{-1}e(\beta^-)$ Example: $^{218}_{84}Po \rightarrow ^{218}_{85}At + ^{0}_{-1}e(\beta^-)$ **2) β⁻ decay (electron emission)** General eq'n: $^{A}_{Z}X \rightarrow ^{A-4}_{Z-2}Y + ^{4}_{2}He(\alpha)$ Example: $^{226}_{88}Ra \rightarrow ^{222}_{86}Rn + ^{4}_{2}He(\alpha)$ **3) Gamma decay (γ)** General eq'n: $^{A}_{Z}X^{*} \rightarrow ^{A}_{Z}X + \gamma$ Example: (* indicates excited state of the nuclide) $^{137}_{56}Ni^{*} \rightarrow ^{137}_{56}Ni + \gamma$

Half Life	refers to the time for half of the radioactive nuclei in a given sample to undergo decay. After one half life there is 1/2 of original sample left. After two half-lives, there will be 1/2 of the 1/2 = 1/4 the original sample.  This is an example of an exponential graph - The horizontal axis shows time – it is measured in number of half-lives. - The vertical axis shows the amount or material, or number of radioactive nuclei remaining after decay. (represented by blue dots in the squares).
Activity	refers to measured by number of nuclei decaying per second
Becquerels (Bq)	is for decays per second or kilobecquerels (kBq) or megabecquerels (mBq). One becquerel is 1 count/sec or 1/s or s^{-1}.
Geiger counter	is used to measure the activity of a radioactive material. It is a type of radiation detector invented to measure x-rays and other ionizing radiation, since they are invisible to the naked eye. It detects radiation such as alpha particles, beta Particles and gamma rays. It was invented by Hans Geiger.
Mass - Energy Equivalence Equation	$E = \Delta mc^2$ = energy (measured in joules, J) m = mass (measured in kilograms, kg) c = the speed of light (measured in metres per second, ms-1)
Fission	the splitting of a heavy nucleus into two nuclei with smaller mass numbers. This process is induced by absorption of a neutron by the reactant nucleus, and results in the release of energy and an additional 2 or 3 neutrons as products. For example 3 of the many possible outcomes of uranium-235 fission are:
Fusion	the combining of two light nuclei to form a heavier, more stable nucleus. For example, the following reactions (among others) take place in the sun:

The CANDU reactor **CAN**adian **D**euterium **U**ranium	**Calandria** is the reactor core that contains a moderator, and the nuclear fuel to achieve nuclear fission. **Nuclear fuel** (natural uranium 235) is a material that can be consumed to derive nuclear energy **Moderator** is a medium which reduces the velocity of fast neutrons, **Deuterium** (Heavy water) is used as a modulator. Heavy water is chemically and physically identical to regular water, with the exception that the extra neutron in each atom of hydrogen makes it more dense. **Control Rods** (shut off Rods)control the distribution of power in the reactor and can be used to shutdown the reactor.
CANDU Safety Systems	Moderator Dump - The heavy water moderator passes through the calandria by gravity. If no more heavy water is 'poured', the reactions stop because there is no moderator slowing down neutrons. 1. Cadmium Control Rods - Cadmium rods, which absorb neutrons, can be lowered into the core remotely to control the reactions. These rods are dropped from electromagnetic clutches and stop the reactions, if there is a power outage. 2. Moderator "Poison" - A neutron-absorbing solution can be injected into the moderator. This stops the chain reactions, while also cooling the core.