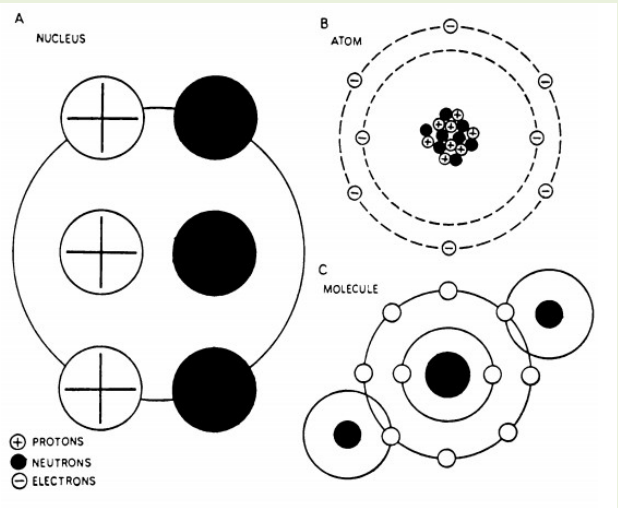
Chapter 1

Reading: Radioactivity

Atomic nuclei consist of combination of protons, or positively charged particles, and neutrons, or uncharged particles. The number of protons and neutrons in each element can vary, but only certain combinations are stable. For example, calcium-48, having 20 protons and 28 neutrons, is a stable isotope of calcium. But ***if there is*** an excess or deficiency of neutrons in any combination, the isotope will be unstable. A nucleus is more likely to be unstable ***if it is*** a heavy one- that is, ***if it contains*** a large number of protons and neutrons. Unstable nuclei attempt to achieve stability by emitting some form of radiation, until they transform themselves into stable isotopes.

There are radioactive isotopes f every element, either those existing in nature or else those activated artificially by bombardment of stable nuclei with nuclear particles such as protons, alpha-particles or neutrons. However, a particle will not be absorbed by target nucleus ***unless its velocity corresponds*** with one of the energy levels of the nucleus. Heavy nuclei, having more energy levels than light nuclei, are more likely to effect capture of a particle- a fact which helps to explain the importance of uranium, thorium and other very heavy atoms in nuclear research.



Since the neutron is uncharged, it is not affected by the charged electrons and protons of the target atom, and is therefore more likely to be captured than any other particle ***provided that it is*** in resonance with an energy level of the nucleus. **In the event of** neutron capture, the mass number of the nucleus will be raised, and it will thus become unstable and radioactive. As radiation continues, the level of radioactivity falls exponentially, and the time taken for it

to reach half of its original value is known as the half-life of its isotope, which may vary from a fraction of a second to milions of years. Isotopes with long half-lives have many uses in medicine and industry, but they must be handled nd disposed of with great care, **in case** they cause radiation damage.

Neurtons bombardment of the very heavy uranium atoms may have a quite different result. It may cause the nucleus of the fissile U-235 atom to split into two parts. This nuclear fission releases large quantities of energy which finally takes the form of heat energy, and at the same time other neutrons are ejected from the nucleus. The fission fragments are highly radioactive, and will contaminate the fissile uranium ***if they are not removed*** periodically. A number of these fission products, such as Caesium-137, are very useful as irradiation sources, and it is now possible to separate out the desired isotope from the spent fuel.

Word study

Charge

1. The cylinders are ***charged with*** compressed air.
2. The furnace is ***charged with*** pulverized fuel and air
3. The accumulator is ***charged*** by passing a current through it.
4. Electrons are negatively ***charged*** while the nucleus is positively charged.

5. An explosive ***charge*** is induced into the combustion chamber.
6. Into the furnace, a ***charge*** of pulverized fuel and air is blown.
7. At intervals a small ***charge*** of lubricant is delivered to each bearing

Particle

Condensation is thought to begin around any tiny dust ***particles***.
The flowing fluid may contain solid ***particles***.
Electrons are negatively charged ***particles***.

Alpha- ***particles*** are high-velocity helium nuclei, and beta- ***particles*** are high-velocity electrons.

Element, Filament

1. He learned the ***elements*** of geology at school. (= basic facts)
2. Oxygen, hydrogen, carbon and potassium are all ***elements***.
3. The problem involves a number of different ***elements***. (= parts)
4. The red-hot wires of an electric fire are ***elements***.
5. Uranium rods inserted into the moderator are fuel ***elements***.

6. The white-hot tungsten wire of an electric bulb is a ***filament***.
7. A thin ***filament*** of coloured fluid is injected into the main stream

Nucleus, Nuclear

1. The organization was built up round a small ***nucleus*** of scientists.
2. The flame spreads from the initial ***nucleus*** to the main body of the mixture.
3. By bombarding it with thermal neutrons, the ***nucleus*** of the uranium atom can be fissioned.

4. ***Nuclear*** energy is liberated as a result of ***nuclear*** fission.

Active, Activate, Excite

1. *a.* Zinc chloride forms the ***active*** base for many proprietary fluxes.
   b. The drug's ***active*** constituent is only a small fraction of the total.
   c. The volcano has not been ***active*** for thousands of years. It is ***inactive.***

2. A nucleus can be artificially ***activated*** by neutrons bombardment.
   A nucleus can be artificially ***excited*** by neutrons bombardment

3. Unstable nuclei ***are radioactive***, and emit ***radioactivity***.

Stable, Stabilize (= not easily changed)

Boron is a ***stable*** substance, which does not burn below 700°C.
Mineral oils are fairly ***stable***, and do not decompose when heated.
Ships are designed to be ***stable***, and should return to an upright position after heeling over.

Only certain combinations of neutrons and protons are ***stable***.
Unstable nuclei emit electrons until they reach a ***stable*** configuration.
Embankments and dams must be ***stable*** enough to resist all forces on them.

Sandy soils can be ***stabilized*** by adding cement to them.
The heavy keel acts as a ***stabilizer*** on a ship.

Patterns

1. Conditions (if)

Note: Here is the commonest way of showing that one event is dependent in some way on another event taking place.
We will deal only with the 'open' condition.

If the weather is good, I shall go for a walk.
Unless the weather is good, I shall stay at home.

Notice that ***unless*** is equivalent to ***if….not***.

If the water is pure, it will not need further treatment.
Unless the water is pure, it will need further treatment.

Tenses: If + Present, Subject + Future (or Present)

2. Conditions (Restrictive)

Note: In addition to the ordinary 'if'-clause, we can express conditions in a more restrictive way:

a. I will come home ***providing*** (that) you come with me. (=otherwise I won't)
I will come home ***provided*** (that) you come with me. (=otherwise I won't)
I will come home ***on condition*** (that) you come with me. (=otherwise I won't)

b. I will come home ***only if*** you come with me. (=not come unless)
I will ***only*** come home ***if*** you come with me. (=not come unless)

c. ***Given + Noun***

Given plenty of labor, the job will be completed on schedule.
Given sufficient turbulence in the combustion chamber, detonation is unlikely to occur.

3. Eventually

Note: Eventually refers to ***unlikely*** (and usually ***unwelcome***) chance that something (usually ***unfortunate***) may happen.

We can of course express this idea simply by saying:

It is (just) possible that…

or there is a remote chance that…

But there are three other patterns which are useful here:

a) ***A normal if-clause+ should***

If a fire ***should*** break out, all workers will leave the building.

If there ***should*** be a fire, all workers will leave the building.

b) ***In the event of***, or occasionally ***in case of*** + ***Noun***

In the event of fire, all workers will leave the building.

In case of fire, all workers will leave the building.

In the event of a fire breaking out, all workers will leave the building.

c) The phrase ***in case***, which means 'because of the risk that … (something may happen)'.

All workers will leave the building, ***in case*** the fire spreads to the chemicals.