

Basic Concepts of Physics

physics – the science that seeks to find the fundamental patterns underlying the behavior simple systems.

matter – the substance of which all physical objects are composed.

length – the measure of distance.

time – the measure of duration.

mass – the measure of matter.

velocity -- the distance traveled in a particular direction by an object divided by the time required to travel the distance.

acceleration -- the change in the velocity of an object divided by the timer over which the change occurred.

force – that which causes a particle to change its motion.

energy – the conserved measure of the motion imparted to a particle by a force, or of the potential motion that can be imparted by the force, or of the effort required to move a particle against a force.

work – energy that is the measure of the effort required to move a particle against a force.

momentum – the conserved measure of the tendency of a particle to continue traveling in a particular direction.

power – the rate at which energy is emitted or absorb by an object.

charge – that property of matter that permits a particular type of force, the electric force, to change its motion.

current -- the amount of charge that flows past a particular position in a particular time divided by that time.

temperature – a measure of the average energy of motion possessed by the particles of a substance.

radiation – that which transfers energy between objects by traveling through the space between them.

Basic Principles of Physics

Energy is conserved

Momentum is conserved

Matter and radiation is made of particles

Nothing can travel faster than light

Mass can be converted to energy

Particle of matter and radiation can behave like waves under certain circumstances.

Electromagnetic radiation can appear as waves of particular frequency.

The energy carried by a particle of radiation is proportional to its frequency.

Macroscopic objects are composed of molecules.

Molecules are composed of atoms.

Atoms are composed of protons, neutrons, and electrons.

Protons and neutrons are composed of quarks.

Radiation's Effect on Tissue

- **Not all radiation is harmful (e.g. light)**
- **Harmful radiation breaks molecular bonds and creates ions**
- **Harmful radiation is called "ionizing radiation"**

Absorbed Dose

quantity of radiation energy absorbed per quantity of tissue

units = energy / mass = 1 Joule / kg = 1 Gray = 100 rad

Gy is abbreviation for Gray

Relative Biological Effectiveness

experimentally determined damage done by radiation compared to that done the same absorbed dose of x-rays

RBE of x-rays = 1.0

<u>radiation</u>	<u>RBE</u>
x-rays	1
electrons	1
protons	5
alpha particles	20
heavy ions	20
slow neutrons	5 – 20

Biologically Equivalent Dose

= RBE x (absorbed dose)

unit = Sievert (when absorbed dose is in Gy)

unit = rem (when absorbed dose is in rad)

1 Sievert = 100 rem

Sv is the abbreviation for Sievert

mSv is the abbreviation for milli Sievert

Radiation Hazards

<u>Source</u>	<u>Bio Equivalent Dose (mSv)</u>
dental x-ray	0.02
chest x-ray	0.2 – 0.4
background radiation	1.0 / year at sea level 2.0 / year at 5000 feet
10-hr plane flight	0.02
FAA flight crew limit	20 / year
Federal occupational limit	50 / year
CT scan	10
PET scan	7

Lethal dose = 5 Sv (death in a few days)

Localized dose of 100 Sv → complete tissue destruction

