• x-rays are useful in medical diagnosis due to their greater penetrating power, enabling them to cast shadows, to varying degrees, of body parts
• higher energy x-rays can also be used for treatment

**Medical Diagnostic X-Ray Images**

• x-rays cannot be focussed onto film, they pass through the glass of a camera lens without significant refraction
• x-ray film is enclosed in a light proof cassette that is placed at right angles to the beam and on the opposite side of the patient to the x-ray source
• sharp shadows, the x-ray source must be point like and the distance between the patient and film small
• x-ray beam incident upon a patient is approximately uniform, the difference in exposure is due to the different amounts of **attenuation** (reduction in intensity) of the beam as it passes through different parts of the body
• attenuation varies due to the x-rays passing through **different thicknesses** and **different types** of tissue
• greater thickness of a given type of tissue results in greater attenuation for a given x-ray beam and therefore a lighter region on the x-ray image
• two properties of tissue have an effect on x-ray attenuation
  • **firstly**, the density, attenuation is proportional to density
  • for example, two types of soft tissue, lung and muscle are chemically similar, but muscle is 3 times as dense as lung tissue and therefore the x-ray beam is attenuated 3 times more, resulting in a lighter region on the x-ray film passing through the same thickness of tissue
  • compact bone is about 1.7 times denser than muscle tissue and therefore their attenuation is greater. It is not 1.7 times greater for the same thickness as muscle and bone tissue are not chemically similar
  • the **second** factor affecting attenuation is atomic number or effective atomic number (the average atomic number taking into account the relative numbers of the different elements present)
  • attenuation of x-rays increases with atomic number
  • dental x-rays, fillings of mercury/silver amalgam or gold are very opaque due to the high atomic number of these elements

**Hardness of X-Rays**

• for high penetrating x-rays, x-ray photons with greater energy is required
• the maximum energy of an x-ray photon is determined by the tubes potential difference (given by \( e\Delta V \))
• hence larger potential differences will result in higher energy photons (between 50 and 125 kV for medical diagnostics)
• x-rays classified in terms of hardness – high energy x-ray photons → hard x-rays → very penetrating
Exposure Time, Tube Current and Filament Current

• an image must be produced with minimum exposure of the patient to x-rays
• hardness of the x-rays is determined →depends upon information required, thickness and type of tissue →fixes potential difference of the tube
• exposure time determined, a short exposure time minimises blurring through movement (note – does not reduce the exposure to the patient) →shorter time, more intense beam of x-rays