24. Medical physics

Starter Quiz · 课前小测

A-Level Physics Name: _____ Score: _____

1. A piezo-electric crystal:

   ☐ changes shape with a p.d., and makes an e.m.f. when squeezed

   ☐ only emits light

   ☐ stores charge like a battery

   ☐ conducts current in one direction only

2. X-rays are produced when fast electrons:

   ☐ hit a metal target and slow down sharply

   ☐ pass through a magnet

   ☐ are heated gently

   ☐ travel through glass

3. A PET tracer is:

   ☐ a positron (β^+) emitter taken up by active tissue

   ☐ a strong magnet

   ☐ an X-ray source

   ☐ an ultrasound gel

4. An echo returns after 2.0×10^{-4} s; the speed of sound is 1500 $\frac{\text{m}}{\text{s}}$. How deep is the boundary?

   _____ m

5. Most of the electrons' kinetic energy in an X-ray tube becomes heat, not X-rays.

   ☐ True ☐ False

6. When the emitted positron meets an electron, they:

   ☐ annihilate into two photons

   ☐ bounce off each other

   ☐ form a stable atom

   ☐ do nothing

7. The coupling gel between the probe and the skin:

   ☐ pushes out air so the ultrasound can enter the body

   ☐ cools the skin

☐ blocks the ultrasound

☐ is only for comfort

8. Each photon from electron–positron annihilation has an energy of (in keV):

   _____ keV

9. Acoustic impedance Z = density × _____.

   _____

10. A higher accelerating voltage gives a _____ minimum wavelength.

    _____

A-Level Physics

1. **changes shape with a p.d., and makes an e.m.f. when squeezed**

   Both effects let one crystal send ultrasound (apply p.d.) and detect it (read the e.m.f.).

2. **hit a metal target and slow down sharply**

   The sudden deceleration on the target gives out X-ray photons (Bremsstrahlung).

3. **a positron (β^+) emitter taken up by active tissue**

   It is a β^+ emitter on a molecule (like glucose) that active tissue absorbs more of.

4. **0.15 m**

   $d = \dfrac{ct}{2} = \dfrac{1500 \times 2.0 \times 10^{-4}}{2} = 0.15$ m (the pulse travels there and back).

5. **True**

   Only a small fraction becomes X-rays — which is why the target must be cooled.

6. **annihilate into two photons**

   Matter and antimatter annihilate: their mass turns into two photons.

7. **pushes out air so the ultrasound can enter the body**

   Without it, the huge skin–air impedance difference would reflect almost all the ultrasound at the surface.

8. **511 keV**

   Each carries $m_e c^2 \approx 0.511$ MeV $= 511$ keV.

9. **speed**

   $Z = \rho c$ — density times the speed of sound in the medium.

10. **shorter**

    $\lambda_{\min} = \dfrac{hc}{eV}$, so a larger V gives a smaller $\lambda_{\min}$ (more energetic X-rays).