Question

What is the correct description of pair-production, where a photon gets converted into an electron-positron pair?

Options

✔ Due to $E = mc^2$ mass and energy are on the same footing, so energy of the photon can be converted into mass of electron+positron. This requires another massive object nearby to also allow conserving momentum.

✖ Due to $E = mc^2$ mass and energy are on the same footing, so energy of the photon can be converted into mass of electron+positron. This is possible even in complete isolation (there is nothing except photon, electron and positron).

✖ Since mass is conserved, electron and positron cannot appear out of nothing, pair production thus just refers to a pre-existing electron and positron to absorb all the energy of the photon.

✖ Photons are in fact bound states of one electron and one positron (thus neutral) that may break up in the presence of another massive object nearby.

Question

How much larger is the momentum of a particle in special relativity compared to classical mechanics, when that particle moves at 0.600 times the speed of light?

Options

- ✔ 1.250 times larger
- ✘ 0.800 times (so smaller)
- ✘ 1.104 times larger
- ✘ 1.038 times larger

Question

What is the momentum of a photon with wavelength 2 nm ?

Options

- ✔ 3.31×10^{-25} kg m/s
- ✘ 6.63×10^{-25} kg m/s
- ✘ 8.28×10^{-26} kg m/s
- ✘ 1.66×10^{-25} kg m/s

Question

An X-ray photon with a wavelength of 1.0000 Angstroms collides with a free electron and as a result gets deflected by a scattering angle of $0.25\ \pi$. What is the wavelength of the photon after the collision?

Options

- ✔ 1.0071 Angstroms
- ✖ 1.0000 Angstroms
- ✖ 1.0142 Angstroms
- ✖ 1.0008 Angstroms

Question

If you shine monochromatic light with wavelength 650 nm onto an anode made of $\mathrm{Potassium}$, which has a workfunction of Phi = 2.2 eV, what is the largest kinetic energy that the emitted photo electrons can have? (Select 0 if there are no photo-electrons).

Options

- ✔ 0.00 eV
- ✘ 0.15 eV
- ✘ 0.45 eV
- ✘ 0.30 eV

Question

You shine mono-chromatic X-rays with a wavelength of 1.50 Angstroms onto a perfect cubic crystal material and record the diffraction peak with the smallest angle at $\theta = 22.00$ degrees (where θ is defined as in the lecture). What is then the lattice constant of the crystal? *Be careful with units and degrees versus radians*

Options

- ✔ 0.20 nm
- ✘ 2.00 nm
- ✘ 4.00 nm
- ✘ 40.04 nm

Question

How did Planck arrive at a calculation for the black body spectrum that correctly describes the experimental observations?

Options

✔ He assumed the electro-magnetic standing waves within the black-body can only attain discrete energies, which are some integer multiple of a constant times the wave frequency.

✖ He assumed the electro-magnetic standing waves within the black-body each only ever have one fixed energy, which is set by the temperature.

✖ He assumed the electro-magnetic standing waves can only have frequencies below some high frequency cutoff, in order to cure the divergence of Rayleigh Jean's law at high frequencies.

✖ He assumed the electro-magnetic standing waves within the black-body can only attain discrete energies, in integer multiples of a basic frequency that only depends on temperature.

Question

If an X-ray tube generates X-rays with a minimal wavelength of 0.50 nm, what kinetic energy must the electrons in it have had?

Options

- ✔ 2479.68 eV
- ✘ 2.48×10^{-6} eV
- ✘ 9918.74 eV
- ✘ 2.48×10^{6} eV

Question

If a black-body has the Temperature T= 800 K, what is the frequency corresponding to the peak of the black body spectrum (see tutorial 3).

Options

- ✔ 4.70×10^{13} Hz
- ✘ 9.41×10^{13} Hz
- ✘ 2.35×10^{13} Hz
- ✘ 1.88×10^{14} Hz

Question

What is the energy of a photon with wavelength 400 nm ?

Options

- ✔ 3.10 eV
- ✘ 6.20 eV
- ✘ 0.77 eV
- ✘ 1.55 eV