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Cumulative test answers for Unit 4

Explanations for the answers to the multiple choice questions.

By Dr Richard Walding

Q	Ans	Explanations
1	A	There are two postulates: (i) The laws of physics are the same in all inertial (uniformly moving) frames of reference; (ii) The speed of light in a vacuum has the same value, c, in all inertial frames of reference. Only Option (A) has either of these. Note that Option B says “any medium” and we know that the speed of light in glass is about 2/3 the speed in a vacuum. Option C is incorrect as an inertial frame is one in which the laws of inertia hold (such as a frame at rest or moving at constant velocity). Option (D) is incorrect as both objects could be moving relative to a stationary object or to another object moving relative to both.
2	B	Stationary observer sees the particle moving so the stationary observer measures dilated time *t*. $t = \frac{t_0}{\sqrt{1-(v/c)^2}}$ $t_0 = t\sqrt{1-(v/c)^2}$ $= 4.7\times10^{-6}\sqrt{1-(2.4\times10^8/3\times10^8)^2}$ $= 4.7\times10^{-6}\sqrt{0.36}$ $= 2.82\times10^{-6}\,s$
3	B	“Rest lifetime” means the decay time in the frame for which the pion is at rest. Hence, that is in the pion’s own frame. Option A is incorrect as the high-energy source of the pion maybe moving relative to the pion when it is created and the pion could move away at a different speed therefore the pion is not at rest to the source. Option C is true for the pion’s own inertial frame (if the pion is at constant velocity, including zero) but it is not true for other inertial frames such as the laboratory or the Earth. Option (D) is wrong as it will be moving relative to the Earth, thus in Earth’s frame the time is the dilated time t. See NCPQ U3&4 SB page 248-9.
4	4	Wien’s displacement law states that $\lambda_{max} = \frac{b}{T}$ where λ_{max} is the wavelength of the peak of the distribution curve of intensity vs wavelength at a given temperature. See NCPQ U3&4 SB page 305. T is the temperature of the radiating object in kelvin, and b is Wein’s displacement constant = 2.898 x 10^{-3} m K.
5	5	$E_K = hf - W$ $= 6.2 - 4.3$ $= 1.9\,eV$ $= 1.9\,eV \times (1.6\times10^{-19}\,J/eV)$ $= 1.9\times1.6\times10^{-19}\,J$
6	C	By definition, at the threshold frequency electrons begin to be emitted at the surface of a metal. Below this frequency no electrons are emitted.

<table>
<tr><td>7</td><td>A</td><td>Blue has a shorter wavelength than red and therefore a higher frequency. This means photons of blue light have a higher energy (E = hf). This means that the energy difference between levels has to be greater for blue than for red. The only one greater than E_3 to E_1 is E_4 to E_1. Note: the syllabus doesn't specifically ask you to recall that blue has a higher frequency than red so this question is unlikely to appear as is. However, I'd learn the names of the colours of the visible spectrum and that frequency increases from R to V. You'd be crazy not to.</td></tr>
<tr><td>8</td><td>D</td><td>Standard Model has matter composed only of quarks and leptons, and we know there are six of each. I know there are also 6 antiquarks, and 6 antileptons but that is not one of the alternatives. Don't complicate things.</td></tr>
<tr><td>9</td><td>B</td><td>This is just one of the four Feynman diagrams you have to be able to identify, draw and explain. No simple way around it so just learn them They are on page 381-3 of my NCPQ U3&4 text.</td></tr>
<tr><td>10</td><td>C</td><td>Here's a table setting out baryon and lepton numbers.
<table>
<tr><td>Ω^-</td><td>$\rightarrow$</td><td>Ξ^0</td><td>e^+</td><td>$\bar{\nu}_e$</td><td></td></tr>
<tr><td>baryon</td><td></td><td>baryon</td><td>positron (anti-lepton)</td><td>Electron anti-neutrino (anti-lepton)</td><td></td></tr>
<tr><td>B = 1</td><td></td><td>B = 1</td><td>B = 0</td><td>B = 0</td><td>$B_R = B_P$ B</td></tr>
<tr><td>L = 0</td><td></td><td>L = 0</td><td>L = -1</td><td>L = -1</td><td>$L_R \neq L_P$</td></tr>
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The baryon number is conserved, but the lepton number (L) is not conserved as there reactants have a lepton number of 0, and the products have a lepton number of -2. The syllabus sys you do not have to determine the baryon numbers and lepton numbers but just be able to say what 'conserved' means. However, I have told you what the baryon numbers are for the two baryons, and you should know the identity of the two leptons. Ther may not be a question like this on the External Exam but it is here to help you understand how it applies. You should thank me for this.</td></tr>
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