

Physics 107: Ideas of Modern Physics

Practice Exam 3

Fundamental constants: $c = \text{speed of light} = 3 \times 10^8 \text{ m/s}$
 $g = \text{accel. of gravity on Earth} = 10 \text{ m/s}^2$
 $G = \text{gravitational constant} = 6.7 \times 10^{-11} \text{ N}\cdot\text{m}^2/\text{kg}^2$

Photon energy $E = hc/\lambda = 1240 \text{ eV}\cdot\text{nm}/\lambda$

1. A scientist is trying to eject electrons from a metal by shining a light on it, but none are coming out. To eject electrons, she should change the light by...
 - a. decreasing the frequency
 - b. increasing the frequency
 - c. increasing the intensity
 - d. increasing the wavelength
 - e. asking Einstein

2. A beta particle, gamma ray, and alpha particle all have the same momentum. Which has the longest wavelength?
 - a. beta particle.
 - b. gamma ray.
 - c. alpha particle.
 - d. all the same.
 - e. depends on gamma ray energy.

3. Particular red (600 nm) and blue (300 nm) lasers both produce 10 mW of power. How do the number of photons per second from each compare?
 - a. Both the same.
 - b. Blue has one quarter as many as red.
 - c. Blue has half as many as red.
 - d. Blue has twice as many as red..
 - e. Blue has four times as many as red

4. A quantum particle in a box is in the lowest energy (ground) state. If the size of the box is decreased, momentum uncertainty of the particle?
 - a. becomes larger
 - b. becomes smaller
 - c. is unchanged
 - d. becomes negative
 - e. cannot be measured

5. A photon is found to have 100 eV of energy. Which answer is closest to its wavelength?
 - a. 12000 nm
 - b. 1200 nm
 - c. 120 nm
 - d. 12 nm
 - e. 1.2 nm

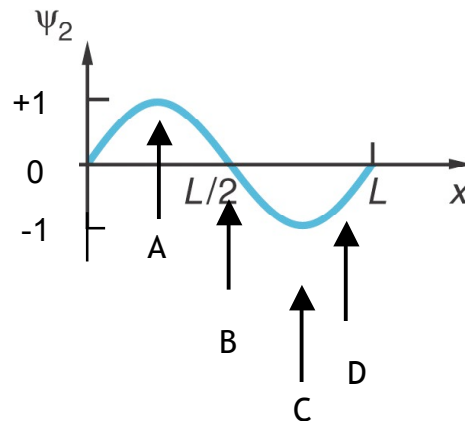
6. Quantum wave-particle duality was the first adequate explanation of which of the following properties of a hydrogen atom?
- An infinite number of possible orbits exist for the electron.
 - More than one possible orbit exists for the electron.
 - Only certain energies are possible for the electron.
 - More than one momentum is possible for the electron.
 - All of the above.

7. A particular quantum system has quantum states with energies $E_{(n=1)}=1$ eV, $E_{(n=2)}=4$ eV, $E_{(n=3)}=9$, $E_{(n=4)}=16$ eV, ... *This is NOT a hydrogen atom.* Calculate the wavelength of a photon emitted as a result of the $n=3$ to $n=2$ transition.

- 140 nm
- 410 nm
- 250 nm
- 1240 nm
- 620 nm

8. For the wavefunction shown below, at which point is the probability of finding the particle the smallest?

- A
- B
- C
- D
- Cannot be determined only from the wavefunction.



9. The force binding together neutrons and protons in the nucleus is
- the Coulomb force
 - the gravitational force
 - the strong force
 - the weak force
 - none of the above

10. Neutral hydrogen has one electron orbiting around its nucleus. Which of the following is NOT the nucleus of an isotope of hydrogen?
- One proton.
 - One proton, one neutron
 - One proton, two neutrons
 - Two protons, two neutrons
 - All of them are isotopes of hydrogen

11. ^{234}U has 92 protons and 234 nucleons total in its nucleus. It decays by emitting an alpha particle. After the decay, it becomes

- ^{232}U
- ^{232}Pa
- ^{230}Th
- ^{230}Ra
- ^{234}Th

U is the element with 92 electrons
 Pa is the element with 91 electrons
 Th is the element with 90 electrons
 Ra is the element with 88 electrons

12. ^{241}Am is used in smoke detectors to ionize gas atoms with alpha particles it emits from its nucleus. In the ^{241}Am nucleus, there are 95 protons and 241 total nucleons. After the alpha emission, ^{241}Am becomes

- ^{239}Np
- ^{237}Np
- ^{239}Pa
- ^{237}Pa
- ^{237}U

Np is the element with 93 protons
 U is the element with 92 protons
 Pa is the element with 91 protons

13. Nuclear fission occurs most commonly

- after nuclear fusion
- after neutron capture
- in low-mass nuclei
- after collision of two nuclei
- at extremely high temperatures

14. That energy is released as a result of nuclear fission is most clearly explained as

- Daughter nuclei bound more tightly than initial nucleus.
- Total number of nucleons changes
- Neutrons ejected during fission can induce a chain reaction
- Incoming neutron transfers energy to the nucleus
- Heavy nuclei can be unstable

15. Which is not a reason that a typical metal at room temperature has a resistance to conducting an electrical current.
- a. the spaces between the atoms are not the proper size to fit the wavelength of the electrons.
 - b. the atoms are vibrating.
 - c. the metal has impurities
 - d. there are missing spaces in the metals crystal matrix
 - e. all of the above
16. A pure semiconductor is an insulator, but becomes useful electrically when
- a. it is cooled to low temperature
 - b. not too large a magnetic field is applied
 - c. some of its atoms are replaced with different atoms
 - d. quantum states are created in it
 - e. it is patterned to very small (nanometer) sizes