ZCT 104/3E Modern Physics
Semester II, Sessi 2004/05
Test I (18 Feb 200b)

1. Which statements is (are) TRUE about photoelectricity according to classical physics?

I)   Light beam of higher intensity is expected to eject electrons with higher kinetic energy from the metal surface
II)   The energy carried by a beam of light is thought to be continuous
III) Light is wave and not comprised of quantum of energy
IV)   When light is irradiated on the metal surface, some time lag is expected before photoelectrons are ejected from the surface

A. **I, II**   B. **II, III**
C. **III**   D. **I, II, III, IV**
E. **Non of A, B, C, D**

2. Let a given metal surface is irradiated with monochromatic light of intensity I_1. Then the same surface is irradiated by monochromatic light with intensity I_2 (where $I_2 > I_1$) but with a longer wavelength. Which of the following statements is (are) true?

I)   The energy of the photon in the beam with intensity I_2 is larger than that in the beam with intensity I_1.
II)   The saturated photocurrents will remain unchanged.
III) The maximum kinetic energy of the photoelectron will increase for the beam with intensity I_2
IV)   The different intensity of light will alter the work function of the metal surface

A. **I, II**   B. **II, III**
C. **III**   D. **III, IV**
E. **Non of A, B, C, D**

3. Which of the following statements is (are) correct about Bohr's atom and a quantum particle trapped inside a simple infinite quantum well of width d?

I)   The gap separating energy levels of higher quantum number becomes closer and closer in the Bohr's hydrogen atom, whereas in the case of particle in a box the gap becomes larger and larger at higher quantum levels.

II)   The electron in the Bohr's atom is subjected to a non-zero potential due to Coulomb's attraction, whereas in the box the particle is subjected to zero potential.
III) The energy levels in the Bohr's atom are negative whereas they are positive for the particle in the well.
IV)   In both cases the particles involved form standing waves

A. **I, II, III, IV**   B. **II, III**
C. **III**   D. **III, IV**
E. **Non of A, B, C, D**

4. Which of the following statements is (are) true?

I)   A particle has a de Broglie wavelength that is related to its linear momentum
II)   A particle's momentum must be quantised in all systems, bounded or unbounded
III) A particle's kinetic energy must be quantised in all systems, bounded or unbounded
IV)   A particle's kinetic energy is only quantised in bounded system

A. **I, II, IV**   B. **I, II, III**
C. **I, IV**   D. **II, III**
E. **Non of A, B, C, D**

5. In order to have photoelectrons ejected from a metal surface in a typical photoelectric effect experiment,

I)   the frequency of the light used must be larger than a certain cut-off value
II)   the intensity of the light used must be larger than a certain cut-off value
III) the wavelength of the light used must be larger than a certain cut-off value
IV)   the saturated photocurrent must be larger than a certain cut-off value

A. **I, II, IV**   B. **I, III**
C. **I**   D. **II, III, IV**
E. **Non of A, B, C, D**

6. Which of the following statements is (are) TRUE regarding photoelectric effect (PE) and Compton effect (CE)?

I)   In PE light behaves like particle, whereas in CE light behave like wave

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II) In PE light behaves like wave, whereas in CE light behave like particle

III) In PE only part of the photon's energy is lost to the atom, whereas in CE all of the photon's energy is lost to the free electron

IV) In PE all of the photon's energy is lost to the atom, whereas in CE only part of the photon's energy is lost to the free electron

A. I, III   B. II, III
C. II, IV   D. IV
E. Non of A, B, C, D

7. Which statements is (are) TRUE about photoelectric and Compton effects?

I) Compton effect experiment confirms that the energy of the quantum of light is proportional to the frequency of the wave model of light

II) Compton effect experiment confirms that the radiant energy of light is quantized into concentrated bundle

III) Photoelectric effect infers that the radiant energy of light is quantized into concentrated bundle

IV) Both Compton effect and photoelectric effect confirm that EM radiation has both wave and particle properties

A. I, III   B. II, III
C. II, IV   D. IV
E. Non of A, B, C, D

8. Which of the following is (are) the correct statement(s) about X-ray production in a conventional X-ray tube?

I) Part or all of the kinetic energy of the moving electron is converted into X rays photon

II) X-rays is emitted when the bombarding electrons undergo Compton scattering

III) The production of x-rays can be considered as a photoelectric process

IV) The shortest wavelength in the x-rays spectrum is the same for different material

A. II, III   B. I, IV
C. II, IV   D. IV
E. Non of A, B, C, D

9. Which of these statements is (are) true about blackbody radiation?

I) Rayleigh-Jeans law is behaving in a physically acceptable manner at short wavelengths

II) Rigel (the blue star) is hotter than Betelguese (red star) because of the position of the peak wavelength in their black body spectrum

III) According to Rayleigh-Jeans law the average energy of the oscillators is given by the equipartition theorem

IV) The spectral distribution of radiation from a blackbody can only be explained in terms of quantised energy levels of the oscillators

A. I, II, III, IV   B. II, III, IV
C. II, IV   D. III, IV
E. Non of A, B, C, D

10. Which of these statements are correct?

I) We conclude that light behave like wave when we find that the light from the sun arrives to the Earth after 8 minutes it was emitted.

II) When we consider light to behave like a particle we expect some detectable time lag for the electron to be emitted from the surface of the metal in a PE experiment.

III) When we consider light to behave like wave we expect some detectable time lag for the electron to be emitted from the surface of the metal in a PE experiment.

IV) Photoelectric effect occurs at the same energy scale as that of the x-rays production because x-rays production is the inverse of the photoelectric process.

A. I, II, III, IV   B. II, III, IV
C. II, IV   D. III, IV
E. III

11. Which of the following statements is (are) TRUE?

I) The energy levels of the atomic orbit is quantized

II) The energy associated with the orbits of the electron in a hydrogen atom is negative because it is not a bounded system

III) $E = 0$ means the electron is free from the bondage of the nucleus' potential field.

IV) Electron at very large quantum number n is tightly bounded to the nucleus by the EM force.

A. I, II, III, IV   B. II, III, IV
C. II, IV   D. III, IV
E. I, III

12. Which of the following statements is (are) TRUE about the Bohr's model of hydrogen-like atom?

I) It applies the Newton's second law for the atom's mechanical stability

II) The angular momentum is postulated to be quantised via $L = nh/2\pi$

III) It assumes the validity of classical electromagnetic theory for the orbiting electron

IV) The only stable orbits of radius r are those that can fit in a multiple number of standing wave of the electron, i.e $2\pi r = n\lambda$

A. I, II, III, IV   B. II, III, IV
C. I, II, IV   D. III,IV
E. Non of A, B, C, D

13. Which of the following statements is (are) true?

I) Thompson suggestion of the Plum Pudding Model is falsified by Rutherford's alpha particle experiment

II) Rutherford suggested the planetary model of atoms.

III) de Broglie is the first to experimentally confirm that electron manifests wave nature.

IV) Frank-Hertz experiment confirms the existence of discrete energy levels in mercury atom

A. I, II, III, IV   B. II, III, IV
C. I, II, IV   D. III,IV
E. Non of A, B, C, D

14. Which of the following statement is (are) true about the Plum-pudding model by Thompson and Rutherford's experiment?

I) Plum-pudding model fails to explain the emission & absorption line spectrum

from atoms because it predicts only a single unique emission frequency.

II) Plum-pudding model cannot explain the 180 degree back-scattering of alpha particle seen in Rutherford's scattering experiment.

III) The planetary model of atoms is plagued by infrared catastrophe

IV) In the Rutherford's alpha particle scattering experiment, the large deflection of alpha particle is caused by a close encounter between alpha particle and the diffused distribution of the positive charge of an atom.

A. I, II, III   B. II, III, IV
C. I, II, IV   D. III, IV
E. Non of A, B, C, D

15. Which of the following statements is (are) true regarding the basic properties of atoms?

I) Atoms are of microscopic size, $\sim 10^{-10}$ m
II) Atoms are stable
III) Atoms contain negatively charges, electrons, but are electrically neutral.
IV) Atoms never emit and absorb EM radiation.

A. I, II, III   B. II, III, IV
C. I, II, IV   D. III, IV
E. Non of A, B, C, D

16. Which of the following statements is (are) true about Bohr's hydrogen-like atom?

I) The increase in the quantum number n means an increase in the energy of the atomic states.

II) When n approaches infinity, the energy of the hydrogen atom become infinity.

III) Free electron is the electron which has the smallest quantum number n

IV) The zero point energy is the energy of the lowest possible quantum state

A. I, II, III   B. II, III, IV
C. I, IV   D. III, IV
E. Non of A, B, C, D

17. Heisenberg's uncertainty principle is a consequence of

A. the intrinsic wave nature of particle
B. the intrinsic particle nature of wave

C. the indivisible nature of particle
D. the divisible nature of particle
E. probabilistic interpretation of the wave function

IV) Momentum is always conserved in both processes of pair production and pair annihilation

A. I, II, III, IV   B. I, II, III
C. I, IV   D. II, III, IV
E. Non of A, B, C, D

18. Which of the following statements is (are) true about the spectrum from hydrogen atom?

I) Balmer series involves transitions of electron from higher orbits to the $n = 2$ orbit

II) Balmer series is the first spectral series of hydrogen atom observed

III) When electron in higher orbit is de-excited to lower orbit, photons of discrete frequency are emitted from the atom, as seen in the emission spectrum

IV) When electron in lower orbit is excited to higher orbit, photons of discrete frequency are absorbed by the atom, as seen in the absorption spectrum

A. I, II, III, IV   B. II, III, IV
C. I, IV   D. III, IV
E. Non of A, B, C, D

19. Which of the following statements is (are) true regarding a quantum particle trapped inside an infinite well of width L?

I) It forms stationary (standing) waves inside the well

II) The linear momentum of the particle becomes quantised

III) The minimum energy of the particle inside the well is given by $h^2/8mL^2$

IV) The energy of the particle inside the well can take on negative value

A. I, II, III, IV   B. I, II, III
C. I, IV   D. III, IV
E. Non of A, B, C, D

20. Which of the following statements is (are) true regarding pair production and pair annihilation of electron-positron pair?

I) Pair annihilation occurs only above the threshold energy of $2m_ec^2$

II) Pair production occurs only above the threshold energy of $2m_ec^2$

III) Energy is always conserved in both processes of pair production and pair annihilation

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