OBAFEMI AWOLOWO UNIVERSITY, ILE-IFE.

DEPARTMENT OF PHYSICS

INTRODUCTORY MODERN PHYSICS (PHY 205)

EXAMINATION FOR 2012/2013

Time Allowed: 2 hrs

INSTRUCTION:

Answer all the questions and where necessary, make use of the following constant:

The speed of light in vacuum, $c = 3.0\times10^{8} ms^{-1}$; Energy radiated by the sun in 1 sec $= 3.92\times10^{26} J$

Planck's constant, $h = 6.63\times10^{-34} J.S = 4.14\times10^{-15} eV$; Rest mass of electron, $m_o = 9.11\times10^{-31} kg$.

Bohr constant $9.0\times10^{9} N.m^2/C^2$; Electronic change $= 1.60^2\times10^{-19} C$; $1.60\times1V^{-19} J = 1eV$

Constant for Balmer series, $R = 1.097\times10^{7} m^{-1}$; Wien's constant $= 2.898 \times 10^{-3}$ mK

Compton wavelength of an electron, $\lambda = 0.024$ Å;

The attenuation coefficient of lead for 1.0 MeV x-rays = 0.70.

1. Which of the following is/are correct about the basic assumption of Bohr's theory as it applies to hydrogen atoms
   - (i) The electron moves in a circular orbit about the proton under the influence of the coulomb force of attraction.
   - (ii) Only certain electron orbits are stable
   - (iii) Radiation is emitted by the hydrogen atom when the electron jumps from more energetic state to a less energetic state.
   - (iv) The size of the allowed electron orbits is determined by a condition imposed on the electron's orbital angular momentum.

   (a) i and iv only (b) i, iii and iv only (c) i, ii, iii and iv (d) ii and iv only (e) None is correct.

In order to produce a 656.3 nm wavelength photon emitted in the Balmer series, a specific frequency and energy are required. Use this information and the constant provided in the previous page to answer question 2 and 3.

2. What is the actual frequency?
   (a) 4.57×10^{14} Hz (b) 8.12×10^{8} Hz (c) 18.05×10^{6} Hz (d) 6.13×10^{10} Hz (e) None is correct.
3. Calculate the photon's energy.
   (a) 3.31 eV (b) 1,89 eV (c) 7.29 eV (d) 23.44 eV (e) None is correct.
4. Semiconductors doped with donor atoms and having electrons as their charge carrier are referred to as
   (a) N-type semiconductors (b) P-type semiconductors (c) P-N-P semiconductors
   (d) N-P-N semiconductors (e) None is correct.
5. What is the frequency of light which will cause electrons to be emitted from a magnesium surface whose work function and kinetic energy are 3.68 eV and 2.52 eV?
   (a) 7.2×10^{22} Hz (b) 1.5×10^{15} Hz (c) 21.5×10^{11} Hz (d) 6.1×10^{10} Hz (e) None is correct.
6. The phenomenon in which x-ray photon is scattered from an electron such that the scattered photons have small frequency than the incident photon is referred to as
   (a) Photonic effect (b) Scattered effect (c) Compton effect (d) Radiation effect (e) None is correct
7. What is the De-Broglie wavelength for a baseball of mass 0.15 kg moving at a speed of 13.0 ms^{-1}.
   (a) 1.95×10^{-34} m (b) 8.56×10^{-34} m (c) 18.15×10^{-34} m (d) 3.40×10^{-34} m (e) None is correct

An atom loses energy by radiating away a photon in the course of motion. The process takes 1.5×10^{-8} s. Use this information to answer 8 and 9.

8. What is the uncertainty in the energy of the photon?
   (a) 1.5×10^{-18} J (b) 7.0×10^{-27} J (c) 8.3×10^{-25} J (d) 3.4×10^{-14} m (e) None is correct
9. What is the uncertainty in its frequency?
   (a) 1.10×10^{7} Hz (b) 2.34×10^{16} Hz (c) 1.25×10^{9} Hz (d) 3.40×10^{20} Hz (e) None is correct

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10. The fact that a wave can exhibit particle-like character and the vice versa best describe a phenomenon known as
(a) Particle kinematics (b) wave anomalls (c) wave-particle duality (d) wave diffraction (e) None is correct.

11. The mass of an electrically neutral particle is ten times greater than that of proton in a nuclide. Assuming the atomic number is exactly one-fifth of the square root 225, what is the nucleon (mass) number?
(a) 3 (b) 33 (c) 24 (d) 30 (e) None is correct.

12. Which of the following expression according to Schrödinger correctly represent the conservation of energy of an electron? Each symbol retain their usual meaning
(a) $\frac{p}{2m^2}$ (b) $\frac{p^2}{2m}$ (c) $\frac{2m}{p^2}$ (d) $\frac{2p}{m^2}$ (e) None is correct.

13. Calculate the cut-off wavelength which corresponds to the maximum frequency produced by a potential difference of 45.0 KV.
(a) 4.5×10^{13} m (b) 2.8×10^{11} m (c) 3.3×10^{7} m (d) 8.2×10^{2} m (e) None is correct

14. The plane wave $\psi(x,t)$ of a monochromatic beam of electrons of uniform intensity, according to Schrödinger can be expressed as
(a) $a\exp i\left(\frac{2x}{\lambda}-wt\right)$ (b) $a\exp i\left(\frac{\lambda x}{2\pi}-wt\right)$ (c) $a\exp i\left(\frac{2\pi x}{\lambda}-wt\right)$ (d) $a\exp i\left(\frac{2\pi t}{\lambda}-wx\right)$
(e)None is correct.

15. The basic principle of expression for the number of electron in an atom with respect to a particular set of quantum number is known as
(a) Pauli exclusion principle (b) Leyman exclusion principle
(c) Balmer exclusion principle (d) Bohr exclusion principle (e) None is correct.

16. Which of the following is/are the possible means of distinguishing crystalline solid?
(i) the conductivity (ii) the resistivity (iii) pressure coefficient of resistivity (iv) the number density of change carrier.
(a) i and ii only (b) i and iii only (c) ii and iv only (d) iii only (e) None is correct.

17 Solids whose atom are arranged in a repetitive 3-dimentional structure is referred to as
(a) solid bond (b) fluid (c) lattice (d) triple solid None is correct

18 If no current exist within a solid at the point of application of potential different, such a solid is
(a) resistor free solid (b) a semi conductor (c) an electrical insulator
(d) an electrical conductor (e) None is correct.

19 The uncertainty of the knowledge of a particles position is related to the uncertainty of its
(i) momentum (ii) energy (iii) time
(a) i only (b) ii and iii only (c) i and ii only (d) i, ii and iii only (e) None is correct.

20 The sum of individual masses of X always exceeds the mass of the stable nucleus for mass defect, whenever X represent
I the unstable nucleus II Protons III Neutrons IV Electrons
(a) I and II only (b) II and III only (c) I only (d) II and IV only (e) None is correct.

21. Which of the following is/are not correct about atoms and its model
(I) atoms are unstable (II) Atom exist without change for billion of years
(III) atoms combine with each other to form rigid solid

(IV) atoms moves freely and never stick together
(a) I and IV only (b) II only (c) III only (d) II and IV only (e) None is correct.

22. The spacecraft is moving past the earth at a constant speed of 0.64c. The astronaut measures the time interval between successive "ticks" of the spacecraft clock to be 2.0 seconds. What is the possible loss in time?
(a) 0.41 sec (b) 0.60 sec (c) 3.93sec (d) 1.93sec (e) 0.36sec

23. The sun radiates electromagnetic energy at the rate of 3.92×10^{26}W. How much mass is transformed into energy each second.
(a) 4.36×10^{9}kg (b) 1.92×10^{18}kg (c) 4.36×10^{3}kg (d) 1.92×10^{10}kg (e) 3.21×10^{9}kg.

24. The net force acting on a body measured in an inertial reference frame is zero whenever
(i) the body remains at rest, (ii) Newton 2nd law is applied
(iii) the body is moving at a constant velocity, (iv) the acceleration is equal to the net force
(a) I & (IV) only (b) I & III only (c)II,III & (IV) only (d) (III & (IV) only (e) I, II, III, IV.

25. The energy required to separate the nucleus into its constituent protons and neutrons is called
(a)Nuclear Energy (b) Nucleon Energy (c) Binding energy (d) Separation Energy
(e) None of the above.

26. Calculate the angular momentum of an electron orbiting around a circular path of radius 2.0×10^{-3} m with an angular speed of 5.0×10^{27} rad/s.
(a) 1.82×10^{-8} (b) 5.23×10^{-15} (c) 6.57×10^{-37} (d) 2.84×10^{-11} (e) None is correct.

27. The wave that is emitted or produced by object when an electron is accelerating and carrying away energy along its path is referred to as
(a) Electromagnetic wave (b) Electronic wave (c) Mechanical wave (d) Magnetic wave
(e) None is correct

28. The assumption that there was no nucleus at the centre of an atom, except a positive charge spread throughout the atom, was pictured earlier by
(a) Ernest Rutherford (b) J. J. Thomson (c) Einstein (d) Bohr (e) J.J. Balmer

29. Which of the following correctly represent an expression for the Bohr magneton μ_B? (Each symbol retain its usual meaning)
(a) $\frac{eh}{8\pi m}$ (b) $\frac{eh}{2\pi m}$ (c) $\frac{eh}{4\pi m}$ (d) $\frac{eh}{\pi m}$ (e) none of the above.

30. The energy required to separate the nucleus into its constituent protons and neutrons is called
(a)Nuclear Energy (b) Nucleon Energy (c) Binding energy (d) Separation Energy
(e) None of the above.

31. Which of the following is not correct about a blackbody radiation?
(a) It is an idealized object that reflects all electromagnetic radiation that falls on it.
(b) It emits a temperature dependent of spectrum of light.
(c) This thermal radiation from it is termed black-body radiation.
(d) It has the emissivity of unity.
(e) None is correct.

32. Yellow light with a frequency of approximately 5.1×10^{14} Hz is the predominant frequency in sunlight. What is the energy carried by a photon having this frequency?

(a) 3.85 eV (b) 2.11 eV (c) 3.38 eV (d) 2.5 eV (e) None is correct.

33. Which of the following statements is not correct?
(a) All abject radiate energy continuously in form of electromagnetic waves due to thermal vibrations of the molecules.
(b) Stefan's Law states that the rate at which an object radiates energy is proportional to the fourth power of its absolute temperature.
(c) Wien's displacement law shows how the spectrum of black body radiation at any temperature is related to the spectrum at any other temperature.
(d) A consequence of Wien's displacement law is that the wavelength at which the intensity of the radiation produced by a black body is a minimum λ_{min}, it it a function of only the temperature.
(e) None is correct.

34. If the temperature of the skin is approximately 35 °C. At what wavelength does the radiation emitted from the skin reach its peak?
(a) 940 μm (b) 289 μm (c) 938 μm (d) 783 μm (e) None is correct.

35. Which of the following statements is not true about photoelectric effect?
(a) It is a phenomenon in which electrons are emitted from matter (metals and non-metallic solids, liquids or gases) as a consequence of their absorption of energy from electromagnetic radiation.
(b) For a given metal, there exists a certain minimum frequency of incident radiation above which no photoelectrons can be emitted.
(c) Red light will not cause the ejection of electrons, no matter what the intensity.
(d) Increasing the intensity of the light increased the number of photoelectrons, but not their maximum kinetic energy.
(e) None is correct

36. Which of the following expressions is not correct about photoelectric effect for a photon with frequency f, incident of the surface of matter with threshold frequency f_o, work function φ, and K_{max} being the maximum kinetic energy of the photoelectrons.
(a) $K_{max} = hf - \varphi$ (b) $\varphi = hf_o$, (c) $K_{max} = h(f - f_0)$
(d) $hf = K_{max} - \varphi$ (e) None is correct.

37. The uses of X-ray include the following except?
(a) Radiodiagnostic (b) Radiotherapy (c) Chemotherapy (d) the detection of pathology of the skeletal system. (e) None is correct.

38. Calculate the minimum wavelength produced when electrons are accelerated through a potential difference of 6.63×10^5 V, a not-uncommon voltage for an X-ray tube.
(a) 1.24×10^{-11} m (b) 6.63×10^{-11} m (c) 1.88×10^{-12} m (d) 2.18×10^{-19} m (e) None is correct.

39. Which of the following statements is not correct about Compton scattering?
(a) It is a type of scattering that X-rays and gamma rays undergone in matter.
(b) It is an inelastic scattering of photons in matter that results in a decrease in energy.
(c) Part of the energy of the X-rays or gamma rays is transferred to a scattering electron.
(d) The wavelength of the scattered rays is sometimes greater than the initial wavelength.
(e) None is correct.

40. Which of the following is a medium energy phenomenon?
(a) Photoelectric effect (b) Compton scattering (c) Pair production (d) Pair annihilation
(e) None is correct.

e process by which X-rays are produced when fast moving electrons are suddenly stopped by a target known as;
(a) Bremsstrahlung (b) X-rays fluorescence (c) synchrotron (d) X-rays luminescence. (e) None is correct.

42. Which of the following is different from others?
(a). X-rays (b) γ-rays (c) Cathode rays (d) Ultraviolet rays. (e) None is correct.

43. Assuming that the tungsten filament of a light bulb is a blackbody, determine its peak wavelength if its temperature is 2900 k.

(a) 999 nm (b) 2898 nm (c) 2989 nm (d) 0 nm (e) None is correct.

4. Calculate the energy carried by an X-ray of wavelength 5.0 Å.
(a). 4.0×10^{-16} J (b). 3.3×10^{-16} J (c). 1.1×10^{-12} J (d). 3.3×10^{-24} J (e) None is correct.

5. The Wien's approximation may be derived from Plank's law by assuming that which of the following is true:
(a) $h\nu >> kT$ (b) $h\nu << kT$ (c) $h\nu = kT$ (d) $h\nu - kT = 0$ (e) None is correct.

46. The SI unit for equivalent dose is:-

(a) Gray (b) joule/kilogram (c) coulomb/kilogram (d) Sievert (e) None is correct.

47. Which of the following statement is not true about pair production?
(a) It is one of the most demonstrations for the presence of space matter in atoms.
(b) When higher energy electron (1.022 MeV and above) are passed through near a heave nucleus it can result the production of one electron and one positron.
(c) It is an inverse of pair annihilation.
(d) When it occurs the equal amount of energy of space matter will be entered from outside of the atom and the natural densities of the space matter in the atomic shells is maintained.
(e) None is correct.

48. Which of the following statements is true?
(a) Wien's equation does accurately describe the short wavelength spectrum of thermal emission from objects but it failed to accurately fit the experimental data for high frequency.
(b) Wien's equation does accurately describe the long wavelength spectrum of thermal emission from objects but it failed to accurately fit the experimental data for low frequency.
(c) Wien's equation does accurately describe the short wavelength spectrum of thermal emission from objects but it failed to accurately fit the experimental data for low frequency.
(d) Wien's equation does accurately describe the long wavelength spectrum of thermal objects but it failed to accurately fit the experimental data for high frequency.
(e) None is correct.

Which of the following statements is/are true?
(i) Planck law approximately equals the Wien's approximation at high frequencies
(ii) Planck function reduces to the Rayleigh-Jean in the limit of large wavelength or low frequency.
(iii) Rayleigh-Jean law accurately describes the long wavelength end of the spectrum of black body radiation.
(iv) At room temperatures black bodies emit mostly infrared wavelengths.

(a) (iv) Only (b) (ii) and (iv) (c) only (i), (ii) and (iv) (d) (i), (ii), (iii) and (iv) (e) None is correct.

50. A sphere that is perfectly blackbody radiator has a radius of 0.07 m and is at 200°C in a room where the temperature is 27 °C. Calculate the net rate at which the sphere radiates energy.

(a) 0.11 kW (b) 0.15 kW (c) 0.037 kW (d) 0.056 kW (e) None is correct.

51. Which of the following statement is not true?

(a) The charge to mass ratio of an object is the charge of an object divided by the mass of the same object.

(b) It is easier to determine the specific charge of the electron e/.n from which the mass m can be calculated if the elementary charge e is known.

(c) If a beam of electrons (the cathode ray) bent into a circular path by a known magnetic field. The value of e/m can be determined from the radius of curvature of the path of the electrons.

(d) The magnitude of the force is independent of the charge of the electron e, its velocity v, but depends on the magnetic field B.

(e) None is correct.

52. Which of the following is not true about cathode ray?

(a) Cathode rays are streams of electrons observed in vacuum tubes.

(b) Evacuated glass tubes that are equipped with at least two metal electrodes to which a voltage is applied.

(c) To release electrons into the tube, they first must be detached from the atoms of the cathode.

(d) Modern vacuum tubes use photoelectric effect.

(e) None is correct.

53. Which of the following is not true about Compton Scattering?

(a) It is a common process in which a photon creates matter.

(b) It is an important effect in gamma spectroscopy.

(c) It is used to detect stray scatter gamma rays to counteract this effect.

(d) It can be used to probe the wave function of the electrons in matter in the momentum representation.

(e) None is correct.

54. Which of the following is not true?

(a) Pair annihilation is the inverse of pair production.

(b) Bremsstrahlung is the inverse of photoelectric effect.

(c) X-ray has a high penetration power because it is massive.

(d) Compton scattering is a type of scattering that X-rays and gamma rays undergo in matter.

(e) None is correct.

55. When light of wavelength 350 nm falls on a potassium surface, electrons with maximum kinetic energy 1.31 eV are emitted. The work function of potassium in this process is

(a) 3.81 eV (b) 2.24 eV (c) 1.52 eV (d) 2.52 eV (e) None is correct.

56. What is the surface temperature of Betelgeuse, a red giant star in the constellation of Orion, which radiates with a peak wavelength of about 970 nm?

(a) 2987 K (b) 3269 K (c) 2402 K (d) 2811 K (e) None is correct.

57. An FM radio transmitter has a power output of 150 kW and operates at a frequency of 99.7 MHz. How many photons per second does the transmitter emit?

(a) 2.49×10^{30} (b) 2.27×10^{30} (c) 4.21×10^{29} (d) 3.36×10^{30} (e) None is correct.

58. What is the minimum voltage required to produce an x-ray with a wavelength of 0.030 nm?

(a) 72.25 kV (b) 14.75 kV (c) 41.4 kV (d) 54.12 kV (e) None is correct.

59. For the recoiling electron and scattered photon to have the same kinetic energy, a 1.6×10^{-3} nm photon was released from a free electron. What is the photon scattering angle for that same energy?

(a) 70° (b) 45° (c) 57° (d) 34° (e) None is correct.

60. Molybdenum has a work function of 4.20 eV. The cutoff wavelength and threshold frequency for the photoelectric effect respectively are;

(a) 543 nm, 1.94×10^{15} Hz (b) 832 nm, 3.10×10^{15} (c) 158 nm, 263×10^{15} Hz

(d) 296 nm, 1.01×10^{15} Hz (e) None is correct.

5. A 4.0 cm^2 detector placed a
of heat radiation.

(a) Calculate the temperature of the blackbody.

(b) At what wavelength is radiation from this blackbody the most intense?

(c) The wave function of a particle in a one-dimensional potential well is given by

$$\psi(x) = \begin{cases} 0 & \text{for } x < 0 \\ A \sin kx & \text{for } 0 \le x \le L \\ 0 & \text{for } x > L \end{cases}$$

Normalize the wave function.

6. A beam of 100 eV neutrons is incident on the surface of a crystal whose inter-atomic distance is 0.91 $\AA$.

(a) Calculate the de Broglie wavelength of the neutrons.

(b) At what angle from the incident beam would the reflected beam have maximum intensity?

(c) The position of an electron can be located within a one dimensional well of width 1.2 $\AA$. What is the minimum uncertainty in its velocity?

7. (a) What is the minimum wavelength for x-rays emitted by an x-ray tube operated at 180 kV?

(b) A nuclear energy state has a lifetime of 98 ns. What is the uncertainty in its energy level?

(c) 10 MeV gamma-rays are to be attenuated using lead. Assume that the absorption coefficient of lead to photons of this energy is 64 m^{-1}, calculate the thickness of lead needed to reduce the intensity of the gamma-rays to 10% of the incident intensity.

$\Delta p \cdot \Delta x \geq \frac{\hbar}{2}$

$p = mv$

$p = \frac{h}{\lambda}$

$k = \frac{n\pi}{L}$

$\int_{-\infty}^{\infty} |\psi|^2 dx = 1$

$\int_{-\infty}^{\infty} A^2 \sin^2 kx \cdots$

$A^2 \int_{-\infty}^{\infty} \sin^2 kx$

$A^2 \left[\frac{x}{2} - \frac{\sin 2kx}{4k} \right]_{-\infty}^{\infty} = 1$

5. A 4.0 cm^2 detector placed a distance 1.5 m from a blackbody records 45.8 W of heat radiation.

(a) Calculate the temperature of the blackbody.

(b) At what wavelength is radiation from this blackbody the most intense?

(c) The wave function of a particle in a one-dimensional potential well is given by

$$\psi(x) = \begin{cases} 0 & \text{for } x < 0 \\ A \sin kx & \text{for } 0 \le x \le L \\ 0 & \text{for } x > L \end{cases}$$

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$\Delta p \cdot \Delta x \geq \frac{\hbar}{2}$

$p = \frac{h}{\lambda}$ $p = mv$

$p = mv$ $k = \frac{n\pi}{L}$

$\int_{-\infty}^{\infty} |\psi|^2 dx = 1$

$\int_{-\infty}^{\infty} A^2 \sin^2 kx$ $A^2 \left[\frac{x}{2} - \frac{\sin 2kx}{4k}\right]$ $\mu = \frac{1}{m}$

$A^2 \left[\left[\frac{L}{2} - \frac{\sin 2kL}{4k}\right] - \left[\frac{0}{2} - \frac{\sin 0}{4k}\right]\right]$

$A^2 \int_{-\infty}^{\infty} \sin^2 kx$

$A^2 \left[\frac{x}{2} - \frac{\sin 2kx}{4k}\right]_{-\infty}^{\infty} = 1$

2006/2007 HARMATTAN SEMESTER EXAMINATIONS
PHY 205 – INTRODUCTION TO MODERN PHYSICS

Instructions: Attempt ALL questions in Section A, and any THREE questions in Section B

USEFUL CONSTANTS		
Speed of light in vacuum	c	2.998×10^{8} m/s
Quantum of charge	e	1.602×10^{-19} C
Boltzmann's constant	k	1.38×10^{-23} J/K
Planck's constant	h	6.626×10^{-34} J.s
Permittivity constant	ε_0	8.85×10^{-12} $C^2/N.m^2$
Stefan-Boltzmann constant	σ	5.67×10^{-8} $W/m^2.K^4$
Electron rest mass	m_e	9.1×10^{-31} kg
Proton rest mass	m_p	1.672623×10^{-27} kg
Neutron rest mass	m_n	1.674929×10^{-27} kg
1 eV		1.602×10^{-19} J

Useful Integral

$$\int \sin^2 mx\,dx = \left[\frac{x}{2} - \frac{\sin 2mx}{4m}\right]$$

SECTION A (15 marks)

1. State the basic assumptions of Bohr's model of the atom. State clearly the differences between the Bohr's model and Sommerfeld's model of the atom.
2. State four postulates of quantum mechanics.
3. Describe very briefly a phenomenon that clearly illustrates the particle nature of the light. (Photoelectric effect)

SECTION B (45 marks)

4. A beam of electrons, each having a kinetic energy of 5 eV and traveling in the positive x-direction, encounters the following potential barrier

$$V(x) = \begin{cases} 0 & \text{for } x < 0 \\ 15\ eV & \text{for } 0 \le x \le 2.0\ \text{Å} \\ 0 & \text{for } x > 2.0\ \text{Å} \end{cases}$$

(a) Obtain the wave function for the electrons.

(b) Calculate the fraction of the beam transmitted through the barrier.

(c) A beam of light of wavelength 1.00×10^{-11} m scatters from free electrons. At what scattering angle will photons having energy equal to 120 keV be detected?

5 Consider a particle of mass m which can move freely along x-axis anywhere from x = -a/2 to x = +a/2, but which is strictly prohibited from being found outside this region. The particle bounces back and forth between the walls at x = ± a/2 of a (one-dimensional) box. The walls are assumed to be completely impenetrable, no matter how energetic is the particle. The wave function for the lowest energy state of the particle is:

$$\psi(x,t) = \begin{cases} A\cos\frac{\pi x}{a}\, e^{-iEt/\hbar} & -a/2 < x < +a/2 \\ 0 & x \le -a/2 \text{ or } x \ge +a/2 \end{cases}$$

Where A is an arbitrary real constant, and E is the energy of the particle.

a) Justify its use here by verifying that it is a solution to the Schroedinger equation in the region $-a/2 < x < +a/2$; and determine the value of E for this lowest energy state.).

b) Evaluate the expectation values of x, p, x^2, and p^2 for the particle associated with the wave function.).

6 An electron is incident upon a rectangular barrier of height $V_0 = 10$ eV and thickness $a = 1.8 \times 10^{-10}$ m. Evaluate the transmission coefficient T and the reflection coefficient R, as a function of the total energy E of the electron.

Tutorial

DEPARTMENT OF PHYSICS AND ENGINEERING PHYSICS
OBAFEMI AWOLOWO UNIVERSITY, ILE-IFE

2013/2014 Harmattan Semester **PHY 205: Modern Physics**

Practice Questions

1. An atom can radiate at any time after it is excited. It is found that in a typical case the average excited atom has a life-time of about 10^{-8} sec. That is, during this period it emits a photon and is deexcited.
   a) What is the minimum uncertainty $\Delta\nu$ in the frequency of the photon?
   b) Most photons from sodium atoms are in two spectral lines at about $\lambda = 5890$ Å. What is the fractional width of either line, $\Delta\nu/\nu$.
   c) Calculate the uncertainty ΔE in the energy of the excited state of the atom.

2. Consider a microscopic particle moving freely along the x-axis. Assume that at the time t = 0 the position of the particle is measured and is uncertain by the amount Δx_0. Calculate the uncertainty in the measured position of the particle at some later time t.

3. Assume that there is one electron of charge –e inside a spherical region of uniform positive charge density ρ (a Thomson hydrogen atom).
   a) Show that its motion, if it has kinetic energy, can be simple harmonic oscillation about the center of the sphere.
   b) Let the total positive charge have the magnitude of one electron charge (so that the atom has no net charge), and let it be distributed over a sphere of radius r = 1.0×10^{-10} m. Find the force constant k and the frequency of the motion of the electron.

4. The wave function $\psi(x,t)$ for the lowest energy state of a simple harmonic oscillator, consisting of a particle of mass m acted on by a linear restoring force of force density C, can be expressed as $\psi(x,t) = Ae^{-(\sqrt{(mC)}/2\hbar)x^2} e^{-(i/2)\sqrt{(C/m)}t}$ where the real constant A can have any value. Verify that this expression is a solution to the Schroedinger equation for the appropriate potential. (The time-dependent term is a complex exponential).

OBAFEMI AWOLOWO UNIVERSITY, ILE-IFE.

DEPARTMENT OF PHYSICS

INTRODUCTION TO MODERN PHYSICS (PHY 205) EXAMINATION FOR 2011/2012

INSTRUCTION Answer all the questions Time Allowed: 2 hrs.

Where necessary, make use of the following constant:

The speed of light in vacuum, C = $3.0\times10^{8}ms^{-1}$;
Amount of energy radiated by the sun in 1 sec = $3.92\times10^{26}J$
Planck's constant, h = $6.63\times10^{-34}J.S = 4.14\times10^{-15}eV$;
Rest mass of electron, $m_o = 9.11\times10^{-31}kg$.
Bohr constant $9.0\times10^{9}\ N.m^2/C^2$;
Electronic change = $1.60^2\times10^{-19}C$; $1.60\times IV^{-19}J = 1eV$
Constant for Balmer series, $R = 1.097\times10^{7}m^{-1}$.
Wien's constant = $2.898\times10^{-3}\ mK$
Compton wavelength of an electron, $\lambda = 0.024$ Å
The attenuation coefficient of lead for 1.0 MeV x-rays = 0.70

1. In wave-mechanical concepts, the wave picture as a mode for describing natural phenomena is best suitable for this process except:
   (i) Interference (ii) electromagnetic (iii) optical (iv) polarization (v) diffraction
   (a) I&III (b) I,IV&V (c) II&IV (d)III&IV (e)II &III

2. A beam of electrons travels with a definite momentum of magnitude P in the direction of x-axis. If the associated monochromatic wave is 6.0 pm. Calculate the momentum P.
   (a) $1.10\times10^{-25}kgm.s^{-1}$ (b) $5.20\times10^{-25}kgm.s^{-1}$ (c) $7.12\times10^{-25}kgm.s^{-1}$ (d) $4.22\times10^{-25}kgm.s^{-1}$
   (e) $9.12\times10^{-25}kgm.s^{-1}$

3. The spacecraft is moving past the earth at a constant speed of 0.64c. The astronaut measures the time interval between successive "ticks" of the spacecraft clock to be 2.0 seconds. What is the possible loss in time?
   (a) 0.41 sec (b) 0.60 sec (c) 3.93sec (d) 1.93sec (e) 0.36sec

4. The sun radiates electromagnetic energy at the rate of $3.92\times10^{26}W$. How much mass is transformed into energy each second.
   (a) $4.36\times10^{9}kg$ (b) $1.92\times10^{18}kg$ (c) $4.36\times10^{2}kg$ (d) $1.92\times10^{10}kg$ (e) $3.21\times10^{9}kg$.

5. The net force acting on a body measured in an inertial reference frame is zero whenever
   (i) the body remains at rest, (ii) Newton 2nd law is applied
   (iii) the body is moving at a constant velocity, (iv) the acceleration is equal to the net force
   (a) I & (IV) only (b) I & III only (c) II,III & (IV) only (d) (III & (IV) only (e) I, II, III, IV.

6. A beam of 35.0 KeV electrons strikes a molybdenum target, generating the x-rays with high spectrum. What is the cut-off wavelength?
   (a) 15.2 pm (b) 35.5pm (c) 44.1 pm (d) 21.4pm (e) 15.5pm

7. Which of the following correctly represent an expression for the Bohr magneton μ_B (Each symbol retain its usual meaning)

OBAFEMI AWOLOWO UNIVERSITY, ILE IFE
DEPARTMENT OF PHYSICS

PY 205 – INTRODUCTORY MODERN PHYSICS

TEST 2 TIME ALLOWED: 1 HOUR

Instructions: Attempt all Questions

1. Clearly identify those processes that a photon can undergo as it interacts with a material
2. Given that photons of wavelength 40-*pm* with an intensity 5.0×10^{4} photons/m^2/s are incident normally on a 0.30-*m* thick absorber that has an absorption coefficient of $5.2 \times 10^{4}\ m^{-1}$. For these photons, calculate the transmitted intensity.
3. Find the principal quantum number, the binding energy, and the excitation energy of the third excited state of hydrogen.
4. Clearly state the difference(s) between Bohr's model and Sommerfeld's model of the hydrogen atom. Identify the quantum numbers involved in each model.

$\frac{8\pi m}{}$ (b) $\frac{}{2\pi m}$ (c) $\frac{8h}{4\pi m}$ (d) $\frac{eh}{\pi m}$ (e) none of the above.

8. The following are correct about atoms and its nature except that
(a). atoms are stable for a period of decade
(b) atoms combine with each other to form stable nucleus and later from rigid solids.
(c) atoms emit and absorb light.
(d) atoms contain a small positively charged nucleus
(e) all of the above.

9. Which of the following is/are true of an electron that is accelerating?
(i) It radiates electromagnetic wave but the wave is void of energy
(ii) It radiates electromagnetic wave but the waves carry away energy
(iii) The electromagnetic wave cause a decrease to the energy of the electrons
(iv) The electromagnetic wave causes an increase in the energy of the electron.
(a) I & IV only (b) II, III & IV only (c) II & III only (d) I & II only (e) II & IV only

10. Find the difference between the longest and shortest wavelength of the Balmer series
(a) 665nm (b) 356nm (c) 912nm (d) 656nm (e)291nm

11. A collection of discrete packet of energy found in electromagnetic radiation is called
(a) Quanta (b) Threshold (c) Photons (d) Photoelectric (e) Photo magnetic.

12. The idea that there was no nucleus at the centre of an atom but instead, positive charge was assumed to be spread throughout the atom, was pictured by
(a) Ernest Rutherford (b) J. J. Thomson (c)Einstein (d) Bohr (e) J.J. Balmer

13. The work function for a silver surface is 4.73eV. Find the minimum frequency that light must have in order to eject electrons from this surface.
(a) 7.57×10^{19}HZ (b) 2.15×10^{19}HZ (c)4.14×10^{11}HZ (d) 1.14×10^{15}HZ (e) 3.25×10^{8}HZ.

14. The Phenomenon in which x-ray photon is scattered from an electron such that the scattered photons have a smaller frequency than the incident photons is referred to as
(a)Scattering effect (b) Photoelectric effect (c) Compton effect (d) Electromagnetic effect
(e)Balmer effect.

15. A muon created in the upper atmosphere travels toward the earth at a speed of 0.998C. Find on the average how long a muon lives according to an observer on earth.(Lifetime of muon is 2.2×10^{-6}s)
(a)35×10^{-6}s (b)22×10^{-6}sec (c)19×10^{-6}s (d)15×10^{-6}s (e)None of the above.

16. The energy required to separate the nucleus into its constituent protons and neutrons is called
(a)Nuclear Energy (b) Nucleon Energy (c) Binding energy (d) Separation Energy
(e) None of the above

17. The amount by which the sum of the individual masses of the protons and neutrons exceed the mass of stable nucleus is referred to as
(a) Balmer series defect, (b) Energy defect, (c) Electron defect (d) Mass defect (e) Potential defect.

18. Which of the following is/are NOT correct about the atomic nucleus.

The total number of conduction electrons is always equal to the product of numbers of atoms with the

number of valence electrons per atom in a sample.
II. The electrons in the conduction band and the holes in the valence band serve as charge carriers.
III. Thermal agitation causes a certain number of valence-band electrons to jump the energy gap into conduction band.
(a) I only (b) I and III (c) III only (d) I and II only (e) None of the above.

The statement below is correct except that
(a) The energy of the incident photon is always equal to the sum of the scattered and that of the the recoil electron.
(b) The wavelength of the scattered x-rays is always longer than that of the incident x-rays.
(c) The momentum of incident photon is equal to the product of that of a scattered photon and that of the recoil electron.
(d) Light and other electromagnetic waves according to Schrondinger, behave as particles or photons when interacting with material substance.
(e) None of the above.

An electron has been accelerated from rest through a potential difference of 2.5×10^3V. What is de-Broglie wavelength of the electrons.
(a) 6.0×10^{-15}m (b) 3.0×10^{7}m (c) 6.0×10^{9}m (d) 3.0×10^{12}m (e) 6×10^{15}m

The repeating crystal structure of a solid can act like a diffraction grating for electrons. The atoms in the crystal correspond to the lines on a grating. Electrons travelling at a speed of 4.6×10^{7}ms^{-1} are scattered by a crystal whose atomic spacing is 150nm. About how many order of electron diffraction are produced.
(a) 9400 (b) 4912 (c) 9010 (d) 3900 (e) None of the above.

Measurement of the position of an electron shows it to be within a region which is 0.15nm wide. How much uncertainty is there in the electron's momentum.
(a) 1.5×10^{-9}kgms^{-1} (b) 2.24×10^{-25}kgms^{-1} (c) 7.0×10^{-25}kgms^{-1} (d) 8.7×10^{-9}kgms^{-1} (e) 1.5×10^{-5}kgms

The uncertainty principle was first proposed and addressed by
(a) Heisenberg (b) Elisha Huggiw (c) De-Brogle (d) J. Thomson (e) Bohr.

An atom loses energy by radiating away a photon and the process takes 1.5×10^{-8} sec. What is the uncertainty in the energy of the photon?
(a) 2.2×10^{-20}J (b) 7.0×10^{-27}J (c) 1.5×10^{-27}J (d) 4.3×10^{-27}J (e) 7.5×10^{-11}J

Which of the following statement is correct about an object that is truly at rest.
(i) The change in momentum is zero (ii) The object position is completely undefined
(iii) The relative velocity is equally zero.
(a) I only (b) II only (c) I and III only (d) I, II, and III (e) II and III only

The following information to answer questions 26 and 27. In wave-particle duality principle, a particle of 4.50eV in motion has a wavelength 2.0×10^{-12}m

The circular frequency experience by the particle is
(a) 1.10×10^{18}Hz (b) 5.24×10^{11}Hz (c) 8.18×10^{-10} Hz (d) 6.29×10^{-8} Hz (e) 3.14×10^{-12} Hz

The momentum of the particle, P is
(a) $\times 10^{-22}$kgms^{-1} (b) 8.32×10^{-22}kgms^{-1} (c) 4.32×10^{-22}kgms^{-1} (d) 3.32×10^{-22}kgms^{-1} (e) 9.35×10^{-22}kgms

that all the light is green light with wavelength 555nm, what is the number of photons given off
second by the bulb.
(a) 6.2 JS^{-1} (b) 1.3 JS^{-1} (c) 9.4 JS^{-1} (d) 2.7 JS^{-1} (e) None of the above.

29. The momentum of 0.055nm photons is represented with P. Use this information for questions 29, 30.
(a) 5.21×10^{-23}kgm/s (b) 8.73×10^{-23}kgm/s (c) 1.21×10^{-23}kgm/s (d) 11.1×10^{-23}kgm/s (e) 3.67×10^{-23}kgm/s

30. How fast must an electron travel to have this momentum?
(a) $4.13\times10^{5}ms^{-1}$ (b) $13.5\times10^{2}ms^{-1}$ (c) $12.6\times10^{-6}ms^{-1}$ (d) $1.33\times10^{7}ms^{-1}$ (e) None of the above

31. Which of the following statements is correct about photoelectric effect?
A. It takes place with photons with energies from about a few electronvolts to, in high atomic number elements, over 1 MeV.
B. It is an inelastic scattering of photons in matter that results in a decrease in energy.
C. Part of the energy of the X-rays or gamma rays is transferred to a scattering electron.
D. The wavelength of the scattered rays is sometimes greater than the initial wavelength.

32. Which of the following is a high energy phenomenon?
(a) Photoelectric effect (b) Compton scattering (c) Pair production (d) Pair annihilation

33. Which of the following statement is not true about pair production?
(a) It is one of the most demonstrations for the presence of space matter in atoms.
(b) When higher energy electron (1.022 MeV and above) are passed through near a heavy nucleus it can result in the production of one electron and one positron.
(c) It is an inverse of pair annihilation.
(d) When it occurs, the equal amount of energy of space matter will be entered from outside of the atom and the natural densities of the space matter in the atomic shells is maintained.
(e) None of the above

34. Which of the following is not true about photoelectric effect?
(a) For a given metal and frequency of incident radiation, the rate at which photoelectrons are ejected is directly proportional to the intensity of the incident light.
(b) For a given metal, there exists a certain minimum frequency of incident radiation below which no photoelectrons can be emitted. This frequency is called the threshold frequency.
(c) For a given metal of particular work function, increase in frequency of incident beam decreases the intensity of the photoelectric current.
(d) Red light will not cause the ejection of electrons, no matter the intensity level.
(e) None of the above

35. When a photon Compton scatters from an electron at an angle of 60°, the Compton shift is equal to:
(a) Half the Compton wavelength of the electron. (b) The Compton wavelength of the electron.
(c) Zero. (d) Unity (e) None of the above

36. Twice the Compton wavelength of the electron. The measure of X-rays ionizing ability is called
(a) Exposure (b) Dose (c) Absorbed dose (d) Equivalent dose (e) None of the above

37. The measure of the biological effect of radiation on human tissue is:-
(a) Exposure (b) Equivalent dose (c) Roentgen (d) Sievert (e) None of the above

38. The SI unit for equivalent dose is:-
(a) Gray (b) joule/kilogram (c) coulomb/kilogram (d) Sievert (e) None of the above

39. The process of the production of X-rays that produces an emission spectrum is:-
(a) Bremsstrahlung (b) X-rays fluorescence (c) synchrotron (d) X-rays luminescence
(e) None of the above

h of the following cannot be used to detect X-rays:-
tographic plate (b) Bremssrahlung (c) Geiger counter (d) Scintillators
ne of the above

edical uses of X-rays include the following except:-
irport Security luggage scanners (b) head CT scan (c) radiotherapy (d) Magnetic resonance
aging. (e) None of the above

s the Planck constant, f is the frequency of the incident photon, and φ is the work function.
aximum kinetic energy K_{max} of an ejected electron is given by
$K_{max} = hf - \varphi$ (b) $K_{max} = \varphi - hf$ (c) $K_{max} = hf + \varphi$ (d) $K_{max} = \varphi + hf$ (e) None of the above

n are accelerated by a potential difference of 5.0 x 10^3V and strike a target, calculate the
num wavelength of the resulting X-rays.
3 x 10^{10} m (b) 7.3 x 10^{-10}m (c) 2.5 x 10^{-10} m (d) 2.5 x 10^{10}m (e) None of the above

of wavelength λ = 0.200 nm are scattered from a block of material, the scattered x-ray are
ved at an angle of 45°C to the incident beam. Calculate the wavelength of the x-ray scattered
s angle.
2 x 10^{-11} m (b) 7.1 x 10^{-13} m (c) 3.65 x 10^{-11} m (d) 6.78 x 10^{-11} m (e) None of the above

h of the following is not true about emissivity of a material?
is the relative ability of its surface to emit energy by radiation.
is the ratio of energy radiated by a particular material to energy radiated by a black body at the
temperature.
s a measure of a material's ability to radiate absorbed energy.
has the dimension of area (e) None of the above

the initial wavelength, λ' is the wavelength after scattering, h is the Planck constant, m_e is the
of the electron, c is the speed of light, and θ is the scattering angle. The relationship between
ift in wavelength and the scattering angle in comptom scattering is:
$\lambda' = \frac{m_e c}{h}(1 - \cos\theta)$ (b) $\lambda' - \lambda = \frac{m_e c}{h}(1 - \cos\theta)$ (c) $\lambda - \lambda' = \frac{h}{m_e c}(1 - \cos\theta)$
$\lambda - \lambda = \frac{h}{m_e c}(1 - \cos\theta)$ (e) None of the above

the wavelength corresponding to the peak of the radiation curve for the heating element of an
ic oven at a temperature of 1.2 x 10^3 k.
2 nm (b) 6.58 nm (c) 20.54 nm (d) 65.82nm (e) None of the above

very hot day it is possible to cook an egg on the hood of a car. What type of car would you
on which to cook your egg?
ream (b) Yellow (c) White (d) Black (e) None of the above

here that is perfectly blackbody radiator has a radius of 0.07 m and is at 200°C in a room where
mperature is 27 °C. Calculate the net rate at which the sphere radiates energy.
11 kW (b) 0.15 kW (c) 0.037 kW (d) 0.056 kW (e) None of the above

(a) The charge to mass ratio of an object is the charge of an object divided by the mass of object.
(b) It is easier to determine the specific charge of the electron e/m from which the mass m can be calculated if the elementary charge e is known.
(c) If a beam of electrons (the cathode ray) bent into a circular path by a known magnetic field. The value of e/m can be determined from the radius of curvature of the path of the electrons.
(d) The magnitude of the force is independent of the charge of the electron e, its velocity v, but depends on the magnetic field B.
(e) None of the above

51. The cathode rays have the following properties except they
(a) Move in straight lines.
(b) Can produce x-rays if they are of very high energy.
(c) Cause fluorescence.
(d) Are not deflected by electric and magnetic fields traveling in circles in magnetic field and in parabolas in electric fields at right angles to their motion.
(e) None of the above

52. When a certain metal surface is irradiated, photo-electrons are ejected from the metal. The kinetic energy of the ejected electrons depends on the
(a) source of the radiation. (b) the work function of the metal.
(c) detection device for the electrons. (d) intensity of the radiation.
(e) None of the above

53. (i) As the temperature of black body radiation decreases the peak of the black body radiation curve moves to the lower intensities and longer wavelengths.
(ii) Wien's displacement law shows how the spectrum of black body radiation at any temperature is related to the spectrum at any other temperature.
(iii) In Wien's displacement law the wavelength at high intensity of the radiation produced by a black body is at maximum, and it is a function of only the temperature.
(iv) Stefan-Boltzmann law states that the power per unit area of the surface of a black body is directly proportional to the fourth power of its absolute temperature.
(a) Only (iv) is correct (b) only (ii) and (iii) are not correct.
(c) (i), (ii), (iii) and (iv) are correct (d) only (i) and (iv) are correct (e) None of the above

54. Which of the following statements is true?
(a) Wien's equation does accurately describe the short wavelength spectrum of thermal emis from objects but it failed to accurately fit the experimental data for high frequency.
(b) Wien's equation does accurately describe the long wavelength spectrum of thermal emis from objects but it failed to accurately fit the experimental data for low frequency.
(c) Wien's equation does accurately describe the short wavelength spectrum of thermal em from objects but it failed to accurately fit the experimental data for low frequency.
(d) Wien's equation does accurately describe the long wavelength spectrum of thermal em from objects but it failed to accurately fit the experimental data for high frequency.
(e) None of the above.

55. The Wien's approximation may be derived from plank's law by assuming that
(a) $h\nu >> kT$ (b) $h\nu << kT$ (c) $h\nu = kT$ (d) $h\nu - kT = 0$ (e) None of the above

56. (i) Planck law approximately equals the Wien's approximation at high frequencies
(ii) Planck function reduces to the Rayleigh-Jean in the limit of large wavelength
ν = frequency.

Rayleigh-Jeans law accurately describes the long wavelength ... body radiation.
At room temperatures black bodies emit mostly infrared wavelengths.
(a) Only (iv) is not correct. (b) only (ii) and (iv) are not correct
(c) (i), (ii) and (iv) are correct D. (i), (ii), (iii) and (iv) are correct
(e) None of the above.

"Cathode rays" refers to
A stream of particles travelling from the anode to the cathode.
Stream of positive ions travelling to the cathode.
Stream of electrons. (d) a stream of alpha particles (e) None of the above

of the following is different from others?
(a) X-rays (b) γ-rays (c) Cathode rays (d) Ultraviolet rays. (e) None of the above

ate the energy carried by an X-ray of wavelength 6.0×10^{-10} m.
3.3×10^{-12} J (b) 3.3×10^{-16} J (c) 1.1×10^{-12} J (d) 3.3×10^{-24} J (e) None of the above

imum energy required to remove an electron completely from the surface of a given atom is
as:
otential energy. (b) binding energy (c) excitation energy (d) ionization energy
(e) None of the above

$E = \frac{hc}{\lambda}$

$E = \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{6 \times 10^{-10}}$

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TEST 2010/2011

OBAFEMI AWOLOWO UNIVERSITY
DEPARTMENT OF PHYSICS
2010/2011 HARMATTAN SEMESTER
PHY 205: INTRODUCTION TO MODERN PHYSICS

Test

Time allowed: 1 HOUR

INSTRUCTION: Answer all questions and shade the appropriate option in the OMR sheet.

Useful constants:

Electronic charge	$e = 1.6 \times 10^{-19}$
Speed of light in vacuum	$c = 3.0 \times 10^{8}$ m/s
Planck's constant	$h = 6.63 \times 10^{-34}$ J.s
Rest of mass of an electron	$m_o = 9.11 \times 10^{-31}$ kg
Wien's constant	$= 2.898 \times 10^{-3}$ mK
Compton wavelength of an electron	$\lambda = 0.024$ Å
Bohr constant	9.0×10^{9} N.m^2/C^2;
Constant for Balmer series,	$R = 1.097 \times 10^{7}$ m^{-1}

1. Which of the following is not correct about a blackbody radiation?
   (A) It is an idealized object that absorbs all electromagnetic radiation that falls on it.
   (B) It emits a temperature dependent of spectrum of light.
   (C) This thermal radiation from it is termed black-body radiation.
   (D) The angle of the incident radiation is equal to the angle of it reflection.

2. Yellow light with a frequency of approximately 5.8×10^{14} Hz is the predominant frequency in sunlight. What is the energy carried by a photon having this frequency?
   (A) 3.85 eV (B) 2.4 eV (C) 4.0 eV (D) 2.5 eV $E = hf$

3. Which of the following statements is not correct?
   (A) All abject radiate energy continuously in form of electromagnetic waves due to thermal vibrations of the molecules.
   (B) Stefan's Law states that the rate at which an object radiates energy is proportional to the fourth power of its absolute temperature.
   (C) Wien's displacement law shows how the spectrum of black body radiation at any temperature is related to the spectrum at any other temperature.
   (D) A consequence of Wien's displacement law is that the wavelength at which the intensity of the radiation produced by a black body is a minimum λ_{min}, it it a function of only the temperature.

$\lambda = \frac{k}{T}$ 2.898 $\times 10^{-3}$ B Wien's constant

4. If the temperature of the skin is approximately 37 °C. At what wavelength does the radiation emitted from the skin reach its peak?
   (A) 940 µm (B) 289 µm (C) 938 µm (D) 783 µm

$\lambda_m = \frac{2.898 \times 10^{-3}}{310}$ $\lambda = \frac{k}{T}$ $f = 5.8 \times 10^{14}$ $E = hf$ $E = ?$

5. Which of the following statements is not true about photoelectric effect?
(A) It is a phenomenon in which electrons are emitted from matter (metals and non-metallic solids, liquids or gases) as a consequence of their absorption of energy from electromagnetic radiation.
(B) For a given metal, there exists a certain minimum frequency of incident radiation above which no photoelectrons can be emitted.
(C) Red light will not cause the ejection of electrons, no matter what the intensity.
(D) Increasing the intensity of the light increased the number of photoelectrons, but not their maximum kinetic energy.

6. Which of the following expressions is not correct about photoelectric effect for a photon with frequency f, incident of the surface of matter with threshold frequency f_o, work function φ, and K_{max} is the maximum kinetic energy of the photoelectrons.
(A) $K_{max} = hf - \varphi$ (B) $\varphi = hf_o$, (C) $K_{max} = h(f - f_0)$
(D) $hf = K_{max} - \varphi$

7. The medical uses of X-ray include the following except?
(A) Radiodiagnostic of pathology of the skeletal system. (B) Radiotherapy (C) Border security (D) the detection

8. Calculate the minimum wavelength produced when electrons are accelerated through a potential difference of 100 000 V, a not-uncommon voltage for an X-ray tube.
(A) 1.24×10^{-11} m (B) 6.63×10^{-11} m (C) 3.84×10^{-19} m (D) 2.18×10^{-19} m

9. Which of the following statements is not correct about Compton scattering?
(A) It is a type of scattering that X-rays and gamma rays undergone in matter.
(B) It is an inelastic scattering of photons in matter that results in a decrease in energy.
(C) Part of the energy of the X-rays or gamma rays is transferred to a scattering electron.
(D) The wavelength of the scattered rays is sometimes greater than the initial wavelength.

10. Which of the following is a medium energy phenomenon?
(A) Photoelectric effect (B). Compton scattering (C). Pair production
(D). Pair annihilation

11. The process of the production of X-rays that produces an emission spectrum is:-
(A) Bremsstrahlung (B). X-rays fluorescence (C). synchrotron (D). X-rays luminescence.

OBAFEMI AWOLOWO UNIVERSITY
DEPARTMENT OF PHYSICS
2010/2011 HARMATTAN SEMESTER EXAMINATION
PHY 205 – INTRODUCTION TO MODERN PHYSICS

Time allowed: 1 Hour 30 minutes.

INSTRUCTION: Answer all questions and shade the prefrate option in the OMR sheet

Useful constants:

Electronic charge e	=	1.6×10^{-19} C
Speed of light in vacuum c	=	3.0×10^{8} m/s
Planck's constant h	=	6.63×10^{-34} J.s
Rest mass of an electron m_0	=	9.11×10^{-31} kg
Wien's constant	=	2.898×10^{-3} mK
Compton wavelength of an electron	=	0.024 Å
Stefan's Boltzmann constant k	=	5.67×10^{-8} W/m^2.K^4

1. Calculate the speed of an electron having a wavelength of 2Å.
   (A) 1.14×10^{6} m/s
   (B) 3.7×10^{6} m/s
   (C) 1.57×10^{6} m/s
   (D) 3.2×10^{6} m/s
2. An electron is accelerated in vacuum from rest at zero volt towards a plate of 40 kV. The kinetic energy of the electron is;
   A. 4.0×10^{-25} J B. 6.4×10^{-15} J C. 4.0×10^{-21} J D. 2.5×10^{-23} J
3. Which of the following gives rise to line spectral obtained from atoms?
   A. Ionization of an electron from the atom.
   B. Excitation of an electron in the atom.
   C. Kinetic energy of a moving atom.
   D. Change of an electron from a higher to a lower energy level in the atom.
4. The work function of a metal is 4.65 eV and the metal is illuminated with a radiation of 6.68 eV. What is the kinetic energy of the electrons ejected from the surface of the metal?
   A. 1.48 eV B. 4.42 eV C. 11.51 eV D. 2.21 eV
5. An atom radiates 1.5×10^{-19} J when an electron jumps from one level to another level. What is the wavelength of the emitted radiation?
   A. 8.01×10^{-6} m B. 6.62×10^{-7} m C. 3.30×10^{-6} m D. 1.32×10^{-6} m
6. As a safety measure, radioactive materials should be stored in a
   A. Lead-lined box B. Aluminium-lined box C. Wooden box D. plastic bag
7. Which of the following scientists postulated that moving particles exhibit wave properties?
   A. Niels Bohr B. Ernest Rutherford C. Werner Heisenberg D. Louis de Broglie
8. The mode of interaction of electromagnetic waves with matter whereby a photon is totally absorbed leading to the production of photo electrons is known as
   A. Bremsstahlung; B. Photoelectric effect; C. Thomson scattering;
   D. Pair production
9. The temperature of the skin is approximately 35 °C. At what wavelength does the radiation emitted from the skin reach its peak?
   A. 2.80 Å

A. 2.898×10^{-3} W/m^3 B. 5000 W/m^3 C. 3.54×10^{3} W/m^3 D. 5.67×10^{-8}

18. The human body emits its maximum temperature radiation according to:
A. 4566 Å B. 9,348 nm C. 4.46×10^{-7} m D. 0 m

19. I Wien approximation may be derived from Planck's law by assuming
II Planck's law approximately equals the Wien approximation at high frequencies.
III The Rayleigh–Jeans expression agrees with experimental results at large but strongly disagrees at short wavelengths (or high frequencies).

A. Only I and III are correct. B. Only I and II are not correct.
C. I, II and III are correct. D. Only II and III are correct.

20. If the potential across an x-ray tube is 2.50 kV. The minimum wavelength of the photons.
A. 0.05 Å B. 19.89 Å C. 2.43 Å D. 0.78 Å

21. Tungsten is used as the material for the filament in cathode ray tube because.
A. It provides support for the anode.
B. It serves as electrical insulator for the anode
C. It can be raised to a high temperature without melting because its melting point is about 3380°C
D. It increases the speed of the electron in the anode.

22. The wavelength of the yellow spectral emission of sodium street lamp is 6000Å. What is its momentum?
A. 1.105 kgm/s B. 4.2×10^{-6} kg·m/s C. 0.067×10^{-23} kgm/s D. 0 kgm/s

23. Which of the following is not true about the black body radiation?
A. At room temperature, black bodies emit mostly infrared wavelengths.
B. No electromagnetic radiation passes through it and none is reflected.
C. It emits a temperature-dependent spectrum of light.
D. Emits thermal radiation to its surroundings.

24. I. When a beam of X-rays is directed at an atom, an electron is ejected and is scattered through an angle θ.
II. The wavelength of the scattered rays was greater than the initial wavelength.
III. Gamma-ray photons with energy greater than 1.02 MeV may interact with a nucleus to form an electron-positron pair.
IV. Cathode rays are streams of electrons observed in vacuum tubes.

A. I, II, III and IV are correct.
B. Only I and IV are correct.
C. Only II and III are not correct.
D. Only III is correct.

25. An x-ray beam of wavelength 1.0 m bombards free electrons and the photons were scattered at an angle of 90° to the incident beam. What is the Compton shift?
A. 2.98 m B. 2.43 pm C. 6.63 nm D. 4.72 pm

A. It provides support for the anode.
B. It serves as electrical insulator for the anode
C. It can be raised to a high temperature without melting because its melting point is about 3380°C
D. It increases the speed of the electron in the anode.

22. The wavelength of the yellow spectral emission of sodium street lamp is 6000Å. What is its momentum?
A. 1.105 kgm/s
B. 4.2×10^{-6} kgm/s
C. 0.067×10^{-23} kgm/s
D. 0 kgm/s

23. An atom that is initially in an energy level with E = -8.92 eV absorbs a photon that has a wavelength 735 nm. Calculate the internal energy of the atom after it absorbs the photon.
A. 5.3 eV B. 2.1 eV C. 7.2 eV D. 1.97 eV

24. I. When a beam of X-rays is directed at an atom, an electron is ejected and is scattered through an angle θ.
II. The wavelength of the scattered rays was greater than the initial wavelength.
III. Gamma-ray photons with energy greater than 1.02 MeV may interact with a nucleus to form an electron-positron pair.
IV. Cathode rays are streams of electrons observed in vacuum tubes.
A. I, II, III and IV are correct.
B. Only I and IV are correct.
C. Only II and III are not correct.
D. Only III is correct.

25. An x-ray beam of wavelength 1.0 m bombards free electrons and the photons were scattered at an angle of 180° to the incident beam. What is the Compton shift?
A. 2.98 nm
B. 2.43 pm
C. 6.63 nm
D. 4.86 pm

26. The uncertainty principle can be written as:
(i) $\Delta p \Delta x \geq \frac{h}{2\pi}$ (ii) $\Delta x h \geq \frac{\Delta p}{2\pi}$ (iii) $\Delta E \Delta t \geq \frac{h}{2\pi}$ (iv) $Yth \geq \frac{\Delta h}{\Delta \pi}$
A. (i) only B. (iii) only C. (i) and (iii) only D. (ii) and (iv) only.

27. The maximum kinetic energy of the electron emitted from a metallic surface is 1 eV when the frequency of the incident radiation is 7.5×10^{14} Hz. Calculate the minimum frequency of the radiation for which the electrons are emitted.
A. 5.1×10^{14} Hz B. 1.47×10^{14} Hz C. 2.89×10^{14} Hz D. 1.23×10^{14} Hz

28. A light of wavelength 510 nm is incident on a metal resulting in the emission of photoelectrons. If the work function of the metal is 2.20 eV, calculate the energy of the incident photon.
A. 3.65×10^{-19} J B. 1.68×10^{-19} J C. 3.9×10^{-19} J D. 2.20×10^{-19} J

29. Which of the following statements is a correct consequence of the uncertainty principle?
A. The uncertainty in our knowledge of energy and the duration taken to measure it are each less than the Planck's constant
B. Complete knowledge of the position of a particle implies the complete

C. A particle's kinetic energy cannot be measured accurately at any time.
D. Both momentum and energy of a particle can be known with absolute certainty.

30. What is the wavelength of light for the least energetic photon emitted in the Lyman series of the hydrogen atom spectrum lines?
A. 91.1 nm B. 122 nm C. 10.20 nm D. 16.60 nm

31. Determine the uncertainty in the energy of a photon which is radiated in a time interval 10^{-36} s.
A. 6.63×10^{-11}
B. 1.1×10^{-28}
C. 1.47×10^{-31}
D. 3.01×10^{-11}

32. A baseball of mass 0.145 kg is thrown with a speed of 40 m/s. What is the de Broglie wavelength of the ball?
A. 1.05×10^{-34} m
B. 4.2×10^{-34} m
C. 1.14×10^{-34} m
D. 1.68×10^{-34} m

33. What is the de Broglie wavelength of an electron with a kinetic energy of 120 eV?
A. 5.91 nm B. 9.11 nm C. 112 pm D. 1.6 pn

34. Which of the following statement is not true about Schrodinger equation:
A. It is as central to quantum mechanics as Newton's laws are to classical mechanics.
B. The most general form is the time-dependent Schrödinger equation, which gives a description of a system evolving with time.
C. Approximate solutions to the time-independent Schrödinger equation are commonly used to calculate the energy levels and other properties of atoms and molecules.
D. The Schrödinger equation does not takes several different forms.

35. At a given temperature $\lambda_{max} = 6{,}500$Å for a blackbody cavity. What will λ_{max} be if the temperature of the cavity is increased so that the rate of spectral radiation is doubled?
A. 5466 Å B. 1.189 Å C. 6.5 Å D. 4.46 Å

36. The speed of an electron is measured to be 5.0×10^{3} m/s to an accuracy of 0.003%. Find the uncertainty in determining the position of this electron.
A. 112 mm
B. 0.384 mm
C. 0.330 mm
D. 0.124 mm

37. Given that an electron has a wavelength of 3.0Å. The value of its total energy is
A. 2.75 eV
B. 1.66 eV
C. 6.72×10^{-27} J
D. 6.63×10^{-10} J

38. It is found that the average excited atom has a life-time of above 25 ns. Calculate the uncertainty in the energy of the excited state of the atom.
A. 1.32×10^{-8} eV
B. 25.01×10^{-8} eV
C. 3.30×10^{-8} eV
D. 2.14 MeV

39. A microscopic particle moves without any resistance to its motion in the positive x-direction and at an instant t = 0, the position of the particle is measured with an uncertainty of Δx_o. The uncertainty in the measured position of the particle at some time t. The Δx is:

A. $\frac{h}{4\pi\Delta x_o}$

B. $\frac{th}{4\pi m\Delta x_o}$

C. $\frac{\Delta P}{4\pi h}$

D. $\frac{\Delta x_o \Delta P}{4\pi h}$

40. The minimum wavelength emitted by an x-ray tube bought for medical examination of internal organs of the body given that the tubes applied voltage is kilovolts, kV_p is:

A. $\frac{12.4}{kV_p} m$

B. $\frac{hc\lambda}{kV_p} nm$

C. $\frac{2hc}{mkV_p} m$

D. $\frac{1.24}{kV_p} \mu m$

41. To break a chemical bond in the molecules of human skin and thus cause sunburn, photon energy of about 3.5 eV is required. To what wavelength does this correspond?

A. 354 nm

B. 135 nm

C. 789Å

D. 355Å

42. Which of the following statements is not correct about Compton scattering?

A. It is a type of scattering that X-rays and gamma rays undergone in matter.

B. It is an inelastic scattering of photons in matter that results in a decrease in energy.

C. Part of the energy of the X-rays or gamma rays is transferred to a scattering electron.

A. The wavelength of the scattered rays is sometimes greater than the initial wavelength.

43. A student is trying to decide what to wear. The surroundings are at 20°C. If the skin temperature of the unclothed student is 35°C, what is the net energy loss from his body in 10 min by radiation? Assume the emissivity of skin is 0.9 and the surface are of the student is 1.50 m^2.

A. 125 J

B. 308×10^4 J

C. 2.93×10^4 J

D. 7.5×10^4 J

44. Which of the following is a medium energy phenomenon?

A. Photoelectric effect B. Compton scattering C. Pair production

D. Pair annihilation

45. Which of the following statement is not true about pair production?

A. It is one of the most demonstrations for the presence of space matter in atoms.

B. When higher energy electron (1.022 MeV and above) are passed through near a heave nucleus it can result the production of one electron and one positron.

C. It is an inverse of pair annihilation.

D. When it occurs the equal amount of energy of space matter will be entered from outside of the atom and the natural densities of the space matter in the atomic shells is maintained.

46. The X-rays are form of electromagnetic radiation just like visible light that have a wavelength range of 10 to 0.01 nm, corresponding to energy in the range of:-

A. 120 to 1200 keV B. 30 to 130 keV C. 10 to 0.01 keV D. 0.12 to 120 keV

47. Hard X-rays have wavelength in the range of about?
A. 10 to 0.1 nm B. 0.1 to 0.01 nm C. 0.12 to 12 nm D. 12 to 120 nm

48. The measure of energy absorbed by living tissue is called
A. Exposure B. Dose C. Absorbed dose D. Equivalent dose

49. The measure of the biological effect of radiation on human tissue is:
A. Exposure B. Equivalent dose C. Roentgen D. Sievert

50. The SI unit of equivalent dose for X-rays is:
A. Gray B. joule/kilogram C. coulomb/kilogram D. Sievert

51. The process of the production of X-rays that produces an emission spectrum is:-
A. Bremsstrahlung B. X-rays fluorescence C. synchrotron D. X-rays luminescence

52. The inverse of bremsstrahlung process is:
A. Pair production B. Photoelectric effect C. Compton Scattering D. Pair annihilation

53. A Schrödinger's equation for a particle of mass (m), in a box is given by

$$\frac{d^2\psi}{dx^2} + \frac{2m}{\hbar^2}E\psi = 0$$

If A and B are constants and ψ and E are the wave position and energy of the particle respectively. If the solutions are subject to the boundary condition that $\psi = 0$ when $x = 0$. Which of the following equations is the correct solution to the above equation?

A. $\psi = A\cos\sqrt{\frac{2mE}{\hbar^2}}x$ B. $\psi = A\sin\sqrt{\frac{2mE}{\hbar^2}}x$ C. $\psi = A\cos\sqrt{\frac{2m\hbar^2}{E}}x$ D. $\psi = A\sin\sqrt{\frac{2m\hbar^2}{E}}x$

54. Which of the following equations represents the steady-state Schrödinger's equation in one dimension? Where all symbols have their usual meanings.

A. $\frac{d^2\psi}{dx^2} + \frac{2m}{\hbar^2}E\psi = 0$ B. $\psi = A\cos\sqrt{\frac{2mE}{\hbar^2}}x$ C. $\frac{d^2\psi}{dx^2} + \frac{2m}{\hbar^2}(E - V)\psi$ D. $\frac{d^2\psi}{dx^2} + \frac{2m}{\hbar^2}(V - E)\psi$

55. Which of the following statements is true about the Schrödinger' equation?
A. Schrodinger's equation is the fundamental equation of quantum mechanics as the 3rd law of motion is that of Newtonian mechanics.
B. The wave function is the product of time-independent function and a position function.
C. A familiar and quite close analogy to the manner in which energy quantization occurs in solution of Schrödinger's equation is with standing wave in a stretched string fixed at one end.
D. The wave function (Ψ) itself has no physical interpretation but the square of its absolute magnitude evaluated at a particular point at a particular time is proportional to the probability of experimental finding that the body is there at that time.

56. Which of the following expression is not true about a photon with energy E, momentum P, wavenumber K, wavelength, λ and frequency v.
A. $P = \frac{h}{\lambda}$ B. $P = \hbar K$ C. $E = 2\pi\hbar v$ D. $k = 2\pi\hbar/P$

57. A positron collides head on with an electron and both are annihilated. Each particle had a kinetic energy of 1 MeV. The wavelength of the resulting wave is;
A. 6216 Å B. 12431 Å C. 14.4 Å D. 1513Å

58. What is the frequency of an X-ray photon whose momentum is 1.1×10^{-23} kgm/s?
A. $1.24\ 10^5$ Hz B. 5×10^{18} Hz C. 6.68×10^{12} Hz D. 1.05×10^9 Hz

59. An X-ray machine produces 0.1 Å X-rays. What accelerating voltage doe it employ?
A. 2.93×10^4 V B. 1.853×10^3 V C. $1.24\ 10^5$ V D. 2.3×10^7 V

60. The threshold wavelength for photoelectric emission in tungsten is 2,300 Å. What wavelength of light must be used in order for electrons with a maximum energy of 1.5 eV to be ejected?
A. 2,300 Å B. 1,500 Å C. 2743 Å D. 1,800 Å

12. Which of the following is different from others?
(A). X-rays (B). γ-rays (C). Cathode rays (D). Ultraviolet rays.

14. Calculate the energy carried by an X-ray of wavelength 5.0 Å
(A). 4.0×10^{-16} J (B). 3.3×10^{-16} J (C). 1.1×10^{-16} J (D). $3.3 \times$

15. The Wien's approximation may be derived from plank's law by assuming that which of the following is true:
A. $h\nu >> kT$ B. $h\nu << kT$ C. $h\nu \approx kT$ D. $h\nu - kT = 0$

16. Thermal agitation in the course of electron motion causes a certain number of valence- band electrons to jump the energy gap into conduction band
(A) at thermal circulation (B) at pressure agitation (C) at thermal efficiency (D) at thermal equilibrium

17. Distinction among crystalline solid is possible through the following electrical properties except. (i) the conductivity (ii) the resistivity (iii) pressure coefficient of resistivity (iv) the number density of change carrier.
(A) i and ii only (B) i and iii only (C) ii and iv only (D) iii only

18. A beam of 35.0keV electron strike a molybdenum target, generating the x-rays with pronounced spectrum . What is the cut off wavelength
(A) 1.38×10^{-11} m (B) 5.31×10^{-11}m (C) 7.21×10^{-11}m (D) 3.55×10^{-11}m

19. Solids whose atom are arranged in a repetitive 3-dimentional structure is referred to as
(A) solid bond (B) fluid (C) lattice (D) triple solid

20. If no current exist within a solid at the point of application of potential different, such a solid is .
(A) resistor free solid (B) a semi conductor (C) an electrical insulator (D) an electrical conductor.

21. What is the momentum of a 6.0×10^{-15}nm photon in kgm/s
(A) 1.21×10^{-23} (B) 1.51×10^{-10} (C) 5.12×10^{-18} (D) 6.0×10^{-24}

22. How fast must an electron travel to have the momentum in question 6 above
(A) $1.2 \times 10^{22} ms^{-1}$ (B) $9.11 \times 10^{15} ms^{-1}$ (C) $5.21 \times 10^{20} ms^{-1}$ (D) $8.10 \times 10^{18} ms^{-1}$

23. The uncertainty of the knowledge of a particles position in related to the uncertainty of its (i) momentum (ii) energy (iii) time
(A) i only (B) ii and iii only (C) i and ii only (D) i, ii and iii only

24. The position of an object is assumed to be precisely known and that the uncertainty in the position is 1.5×10^{-11}m find the corresponding minimum uncertainty in the speed of the object, if the object is an electron
(A) $3.0\times10^{11}ms^{-1}$ (B) $7.7\times10^{6}ms^{-1}$ (C) $3.0\times10^{24}ms^{-1}$ (D) $7.0\times10^{11}ms^{-1}$

25. What is the frequency of light which will cause electrons to be emitted from a Magnesium surface whose work function is 3.68eV with kinetic energy of 2.52eV
(A) 1.50×10^{15}Hz (B) 6.20×10^{15}Hz (C) 1.51×10^{15}Hz (D) 6.20×10^{24}Hz

26. The statement that the sum of individual masses of X exceeds the mass of the stable nucleus is a correct for mass defect, where X represent
I the unstable nucleus II Protons III Neutrons IV Electrons
(A) I and II only (B) II and III only (C) I only (D) II and IV only

27. The mass of an electrically neutral particle was found to be 6 times greater than that of proton in a Nuclides. If the atomic number is exactly one-third of the square root 81, what is the nucleon (mass) number
(A) 18 (C) 54 (C) 21 (D) 174

28. Which of the following is/are not correct about atoms and its model
(I) atoms are unstable (II) Atom exist without change for billions of years
(III) atom combine with each other to form rigid solid
(IV) atoms moves freely and never stick together
(A) I and IV only (B) II only (C) III only (D) II and IV only

29. The sun radiates electromagnetic energy at the rate of 3.92×10^{26}W. How many mass is transformed into energy each second.
(A) 4.36×10^{9} kg (B) 1.6×10^{9}kg (C) 1.36×10^{9}kg (D) 3.92×10^{15}kg

30. The measure of X-rays ionizing ability is called
A. Exposure B. Dose C. Absorbed dose D: Equivalent dose

2010/2011 TEST

OBAFEMI AWOLOWO UNIVERSITY
DEPARTMENT OF PHYSICS
2010/2011 HARMATTAN SEMESTER
PHY 205 – INTRODUCTION TO MODERN PHYSICS

Test. Time allowed: 50 min

INSTRUCTION: Answer all questions and shade the prorate option in the OMR sheet.

Useful constants:

Electronic charge	$e = 1.6 \times 10^{-19}$
Speed of light in vacuum	$c = 3.0 \times 10^{8}$ m/s
Planck's constant	$h = 6.63 \times 10^{-34}$ J.s
Rest of mass of an electron	$m_e = 9.11 \times 10^{-31}$ kg
Wien's constant	$= 2.898 \times 10^{-3}$ mK
Compton wavelength of an electron	$\lambda = 0.024$ Å
The attenuation coefficient of lead for 1.0 MeV x-rays = 0.70	

1. Which of the following statements is not correct about Compton scattering?
   A. It is a type of scattering that X-rays and gamma rays undergone in matter.
   B. It is an inelastic scattering of photons in matter that results in a decrease in energy.
   C. Part of the X-rays or gamma rays is transferred to a scattering electron.
   D. The wavelength of the scattered rays is sometimes greater than the initial wavelength.
2. Which of the following is a low energy phenomenon?
   A. Photoelectric effect B. Compton scattering C. Pair production
   D. Pair annihilation
3. Which of the following statement is not true about pair production?
   A. It is one of the most demonstrations for the presence of space matter in atoms.
   B. When higher energy electron (1.022 MeV and above) are passed through near a heave nucleus it can result the production of one electron and one positron.
   C. It is an inverse of pair annihilation.
   D. When it occurs the equal amount of energy of space matter will be entered from outside of the atom and the natural densities of the space matter in the atomic shells is maintained.
4. The X-rays are form of electromagnetic radiation just like visible light that have a wavelength in the range of 10 to 0.01 nm, corresponding to frequencies in the range of:-
   A. 120 to 1200 kHz B. 30 pentahertz to 30 exahertz C. 10 to 0.01 kHz
   D. 12.0 to 0.12 MHz
5. Soft X-rays have wavelength in the range of about?
   A. 10 to 0.1 nm B. 0.1 to 0.01 nm C. 0.12 to 12 nm D. 12 to 120 nm
6. The measure of X-rays ionizing ability is called
   A. Exposure B. Dose C. Absorbed dose D. Equivalent dose
7. The measure of the biological effect of radiation on human tissue is:-
   A. Exposure B. Equivalent dose C. Roentgen D. Sievert
8. The *SI* unit for equivalent dose is:-
   A. Gray B. joule/kilogram C. coulomb/kilogram D. Sievert
9. The process of the production of X-rays that produces an emission spectrum is:-
   A. Bremsstrahlung B. X-rays fluorescence C. synchrotron D. X-rays luminescence
10. Which of the following cannot be used to detect X-rays:-
    A. Photographic plate B. Bremssrahlung C. Geiger counter D. Scintillators

OBAFEMI AWOLOWO UNIVERSITY, ILE IFE
DEPARTMENT OF PHYSICS

PHY 205 – INTRODUCTORY MODERN PHYSICS

TEST I TIME ALLOWED: 1 HOUR

USEFUL CONSTANTS

Planck constant	h	6.63×10^{-34} *J.s*
Mass of electron	m_e	9.11×10^{-31} *kg*
Speed of light	c	2.998×10^{8} *m/s*
Charge on electron	e	1.602×10^{-19} *C*
Electronvolt	1 *eV*	1.602×10^{-19} *J*
Avogadro Number	N_0	6.02×10^{26} *atoms/kmole*
Atomic weight of He		4.00 *kg/kmole*

1. The work function for sodium metal is 3.75×10^{-19} *J*. What retarding potential would be necessary to stop photoemission when light of wavelength 3000 Å is shone on a clean surface of the metal?

2. An x-ray photon has an energy of 124 *keV*. After a Compton scattering through 30°, what is the photon's momentum.

3. An electron and a positron, both having kinetic energy 10 *keV* collide and annihilate each other. Calculate the momentum of each photon emitted.

4. What is the de Broglie wavelength for a beam of helium atoms moving at a speed of 1.635×10^{5} *cm/s*?

5. An electron can be found at any point in a potential well of dimension 5.0 *pm*. What is the minimum uncertainty in the electrons momentum?