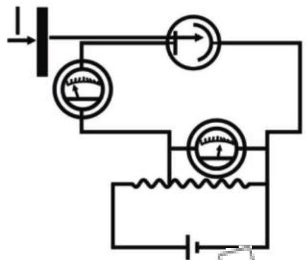

Chapter 19

DAWN OF MODERN PHYSICS

TOPICAL MULTIPLE-CHOICE QUESTIONS

Topic 19.1 & 19.2:

KIPS MCQS

Relative Motion & Frames of Reference

(1) The branch of physics which deals with the behavior of microscopic particles moving with speed of light is called:
(a) microscopic physics **(b)** relativistic mechanics
(c) Newtonian mechanics **(d)** classical physics

(2) A system moving with constant velocity is an example of
(a) inertial frame of reference **(b)** non-inertial frame of reference
(c) accelerated frame of reference **(d)** Cartesian frame of reference

(3) All motions are:
(a) absolute **(b)** relative
(c) uniform **(d)** variable

(4) Any coordinate system relative to which measurement are taken is known as:
(a) infinity point **(b)** frame of reference
(c) zero point **(d)** none of these

(5) An inertial frame of reference is that in which:
(a) $a=0$ **(b)** $a \neq 0$
(c) $a>0$ **(d)** $a=\text{constant}$

(6) A frame of reference is that in which law of inertia is valid is known as:
(a) inertial frame of reference **(b)** non-inertial frame of reference
(c) accelerated frame of reference **(d)** none of these

(7) Newton's laws of motion are valid:
(a) in inertial frame of reference **(b)** in non-inertial frame of reference
(c) accelerated frame of reference **(d)** none of these

(8) Quantum theory has been able to explain the discrete nature of
(a) electromagnetic waves **(b)** magnetic waves
(c) electric waves **(d)** none of these

ENTRY TEST MCQS

(9) Strictly speaking earth is considered as ______
(a) Inertial frame of reference **(b)** Non-inertial frame of reference
(c) Both **(d)** None

Topic 19.3:

Special Theory of Relativity

(10) The special theory of relativity was proposed by:
(a) Newton **(b)** Maxwell
(c) Compton **(d)** Einstein

(11) The special theory of relativity is based upon:
(a) two postulates **(b)** three postulates

(c) four postulates (d) none of these

(12) According to special theory of relativity, all laws of physics are same in all:
(a) non-inertial frames **(b)** inertial frames
(c) accelerated frames **(d)** none of these

(13) According to special theory of relativity, an expression for time dilation is given by:
(a) $t=\frac{t_o}{\sqrt{1-\frac{c^2}{v^2}}}$ **(b)** $t=\frac{t_o}{\sqrt{1-\frac{v^2}{c^2}}}$
(c) $t=t_o\sqrt{1-\frac{v^2}{c^2}}$ **(d)** $t=t_o\sqrt{1-\frac{c^2}{v^2}}$

(14) Due to the relative motion of observer and frame of reference, time:
(a) dilates **(b)** stretches
(c) both a and b **(d)** uniform

(15) According to special theory of relativity, an expression for mass variation is given by:
(a) $m=m_o\sqrt{1-\frac{v^2}{c^2}}$ **(b)** $m=m_o\sqrt{1-\frac{c^2}{v^2}}$
(c) $m=\frac{m_o}{\sqrt{1-\frac{v^2}{c^2}}}$ **(d)** $m=\frac{m_o}{\sqrt{1-\frac{c^2}{v^2}}}$

(16) NAVSTAR is a system of:
(a) communication satellite **(b)** artificial satellite
(c) navigation satellite **(d)** all of these

(17) According to special theory of relativity mass and energy are
(a) same entities but are interconvertible **(b)** different entities but are convertible
(c) different entities but are inconvertible **(d)** same entities but are convertible

(18) At rest the energy equivalent of an object's mass m_o is called
(a) rest mass energy **(b)** moving mass
(c) rest mass **(d)** inertial mass

(19) Einstein mass energy relation given by
(a) $E = mc$ **(b)** $E = m/c^2$
(c) $E = mc^2$ **(d)** $E = c^2/m$

(20) The orbital speed of earth is
(a) $30\ kms^{-1}$ **(b)** $3000\ ms^{-1}$
(c) $300\ kms^{-1}$ **(d)** $30\ ms^{-1}$

(21) According to theory of relativity time is
(a) vector quantity **(b)** not absolute quantity
(c) absolute quantity **(d)** none of these

(22) According to theory of relativity the expression for length contraction is given by
(a) $l=\frac{l_o}{\sqrt{1-\frac{c^2}{v^2}}}$ **(b)** $l=\frac{l_o}{\sqrt{1-\frac{v^2}{c^2}}}$
(c) $l=l_o\sqrt{1-\frac{v^2}{c^2}}$ **(d)** $l=l_o\sqrt{1-\frac{c^2}{v^2}}$

(23) In relation $\Delta m = \frac{\Delta E}{c^2}$, c^2 is very large quantity, this implies that small change in mass require:

(a) very small change in energy **(b)** very large change in energy
(c) no change in energy **(d)** none of these

(24) If relative effects are not taken in account, speed could not be determined any closer than

(a) $20ms^{-1}$ **(b)** $200ms^{-1}$
(c) $20cms^{-1}$ **(d)** $200cms^{-1}$

(25) The length contraction happens only

(a) along the direction of motion **(b)** perpendicular to the direction of motion
(c) opposite the direction of motion **(d)** none of these

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(26) The length contraction happens only________. **GRW-2022 (G-I)**

(a) Perpendicular to direction of motion **(b)** Along the direction of motion
(c) Opposite to the direction of motion **(d)** Along any direction

(27) The theory of relativity was proposed by **SGD-2017 (G-I)**

(a) Newton **(b)** Maxwell
(c) Compton **(d)** Einstein

(28) The mass of object will be doubled at speed. **SGD-2017 (G-I)**

(a) 2.6×10^8 m/s **(b)** 1.6×10^8 m/s
(c) 3.6×10^8 m/s **(d)** 0.6×10^8 m/s

(29) If velocity of a body becomes equal to "C", then its mass becomes:
FSD-2019 (G-I), 2022 (G-I)

(a) 0 kg **(b)** $m = m_o$
(c) $m \to \infty$ **(d)** $m = \frac{m_o}{2}$

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(30) According to special theory of relativity, time is not absolute quantity. This result applies to __________ timing processes

(a) Physical **(b)** Chemical
(c) Biological **(d)** All

(31) The length of meter rod moving with velocity equal to $3\times10^8 ms^{-1}$ appears to an observer at rest as

(a) 1 m **(b)** $\frac{1}{2}$ m
(c) $\frac{1}{4}$ m **(d)** Zero

(32) At which relativistic speed the mass of an object will become double than its rest mass?

(a) $\frac{c}{2}$ **(b)** $\frac{\sqrt{3}c}{2}$
(c) $\frac{2c}{\sqrt{3}}$ **(d)** $\sqrt{\frac{2}{3}}c$

Topic 19.4:

Black Body Radiation

(33) A black body is that which:
(a) absorb infrared radiation only
(b) absorb ultraviolet radiation only
(c) absorb no radiation
(d) absorb all the radiations

(34) The nature of radiation emitted by a body depends upon:
(a) mass of body
(b) volume of body
(c) temperature of body
(d) all of these

(35) When a platinum wire is heated, it appears cherry red at about:
(a) 500^{o}C
(b) 900^{o}C
(c) 1100^{o}C
(d) 1300^{o}C

(36) Absorption power of perfect black body is:
(a) zero
(b) 1
(c) infinity
(d) none of these

(37) The inner surface of cavity of the black body is:
(a) painted red
(b) painted white
(c) blackened with soot
(d) panted green

(38) Mathematically form of Stephen-Boltzmann law is:
(a) $E = \sigma T^2$
(b) $E = \sigma T^3$
(c) $E = \sigma T^4$
(d) $E = \sigma T^6$

(39) According to Max Planck the energy of each quanta is:
(a) $E = mc^2$
(b) $E=mv^2$
(c) $E=\frac{h}{f}$
(d) E=hf

(40) The momentum of a moving photon is:
(a) $p=\frac{h}{f}$
(b) $p=\frac{\lambda}{h}$
(c) $p=\frac{h}{\lambda}$
(d) $p=mc^2$

(41) The momentum of a photon of frequency f is:
(a) hf/c
(b) hc/f
(c) c/hf
(d) f/hc

(42) The energy E of each quantum is proportional to its
(a) velocity
(b) frequency
(c) mass
(d) time period

(43) As the temperature of black body is raised, the wavelength
(a) shifts towards longer value
(b) remain same
(c) shifts towards smaller value
(d) shifts towards longer as well as smaller value

(44) The Planck's constant 'h' has the value of
(a) 6.63×10^{-34}Js
(b) 2.9×10^{-34}Js
(c) 2.9×10^{-3}mK
(d) 6.63×10^{-24}Js

(45) Max Planck received the Noble prize for the discovery of quanta energy in
(a) 1892
(b) 1927
(c) 1601
(d) 1918

(46) Wien's constant is about
(a) 6.63×10^{-34}Js
(b) 2.9×10^{-34}Js

(c) 2.9×10^{-3}mK (d) 6.63×10^{-24}Js

(47) A black body is an
(a) ideal absorber (b) ideal radiator
(c) both a and b (d) good absorber

(48) When the platinum heated at 1300° then its turns
(a) cherry colour (b) yellow colour
(c) red colour (d) dull red colour

(49) At high temperature, the proportion of shorter wavelength
(a) decreases (b) remain same
(c) increases (d) none of these

(50) The value of Stefen's constant is
(a) $5.67 \times 10^{-8}Wm^{-2}K^{-4}$ (b) $5.67 \times 10^{-6}Wm^{-2}K^{-4}$
(c) 2.9×10^{-3}mK (d) 6.63×10^{-24}Js

(51) The energy of photon of radio waves is only
(a) 10^{-10} eV (b) 100 eV
(c) 10^{-5} eV (d) 1 MeV

(52) Planck suggested that energy is radiated or absorbed in discrete packets called
(a) waves (b) photon
(c) quanta (d) all of these

(53) The stream of photons travel with speed of
(a) light (b) greater than speed of light
(c) sound (d) greater than speed of sound

(54) Planck assumed that _________ from hot bodies was due to some property of the atoms producing it.
(a) granular nature of radiation (b) granular nature of absorption
(c) granular nature of wave (d) none of these

(55) The intensity of emitted energy with wavelength radiated from a black body at different temperatures first time was measured by
(a) Lummer and Stefen (b) Lummer and Pringsheim
(c) Stefen and Pringsheim (d) Wein and Stefen

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(56) Radiations emitted by human body at normal temperature 37°C lies in: **LHR-2017 (G-I)**
(a) X-ray region (b) infra red region
(c) visible region (d) ultraviolet

(57) The unit of Plank's constant is: **GRW-2019 (G-II)**
(a) Volt (b) JS
(c) JS^{-1} (d) eV

(58) The numerical value of Stefen's constant is: **SWL-2017, LHR-2019 (G-II)**
(a) 5.67×10^{-8} (b) 2.9×10^{-3}
(c) 6.63×10^{-34} (d) 1.6×10^{-19}

(59) When platinum wire is heated. It changes to cherry red at temperature: **LHR-2021 (G-II)**
(a) 500 °C (b) 900 °C
(c) 1100 °C (d) 1300 °C

(60) If the temperature of the black body is doubled then energy radiated per second per unit area becomes. **GRW-2022 (G-II)**

(a) 32 times (b) 16 times
(c) 64 times (d) 4 times

(61) For a black body, the product λ_m and T is known as; **MIRPUR (AJK) 2017**
(a) Wien's constant (b) Planck's constant
(c) Stephan's constant (d) Coulomb constant

(62) Plank's constant h has the same unit as that of **DGK-2017 (G-II), SGD-2017 (G-II)**
(a) linear momentum (b) angular momentum
(c) torque (d) power

(63) At low temperature, a body emits radiations of: **RWP-2019 (G-I)**
(a) shorter wavelength (b) longer wavelength
(c) high frequency (d) high frequency & shorter wavelength

(64) The value of Stefen's constant "σ" is given by:
MTN-2019 (G-II), LHR-2021 (G-I), GRW-2022 (G-I)
(a) 5.67×10^{-8} Wm^{-2} K^{-2} (b) 5.67×10^{8} Wm^{2} K^{2}
(c) 5.67×10^{-8} Wm^{-2} K^{-4} (d) 5.67×10^{-8} W^2m^2 K^{-2}

(65) Plantinum wire becomes yellow at room temperature of. **FSD-2022 (G-II)**
(a) 500 °C (b) 900 °C
(c) 1100 °C (d) 1300 °C

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(66) As the temperature of black body is raised, the wavelength corresponding to maximum intensity
(a) Shifts towards longer wavelength
(b) Shifts towards shorter wavelength
(c) Remain the same
(d) Shifts towards longer as well as shorter wavelengths

Topic 19.5:

Interaction of Electromagnetic Radiation with Matter

(67) The emission of electrons from a metal surface when exposed to light of suitable frequency is called:
(a) Compton effect (b) pair production
(c) photoelectric effect (d) none of these

(68) Electromagnetic radiation or photons interact with matter in
(a) 2 distinct ways (b) 3 distinct ways
(c) 4 distinct ways (d) 5 distinct ways

(69) A photocell is based on
(a) Compton effect (b) pair production
(c) photoelectric effect (d) none of these

(70) If the threshold frequency of incident light for a metal surface is f_o, its work function (ϕ) will be
(a) $\phi = hf$ (b) $\phi = hf_o$
(c) $\phi = h(f + f_o)$ (d) $\phi = h(f - f_o)$

(71) Photoelectric effect is observed when monochromatic light is allowed to shine on
(a) cathode (b) anode
(c) semiconductor (d) insulator

(72) The security system is an example of
(a) The Compton effect (b) Planck's theory

(c) photo cell (d) photo electric effect

(73) $(K.E.)_{max}= hf-hf_o$ is known as:
(a) Compton equation **(b)** Newton's equation
(c) Planck's equation **(d)** photoelectric equation

(74) Photoelectric effect was discovered by:
(a) Einstein **(b)** Hertz
(c) Max Planck **(d)** Wien's

(75) In photoelectric effect when monochromatic light is allowed to shine on cathode, it begins to
(a) emit electrons **(b)** absorb electrons
(c) emit protons **(d)** emit neutrons

(76) Compton effect makes use of law of conservation of:
(a) energy **(b)** momentum
(c) charge **(d)** all of these

(77) The change of very high energy photon into an electron and positron pair is called:
(a) Compton effect **(b)** pair production
(c) annihilation of matter **(d)** photoelectric effect

(78) When light falls on the metal surface, the energies of the emitted electrons vary with
(a) speed of light **(b)** frequency of light
(c) intensity of light **(d)** remain unchanged

(79) The classical theory cannot explain the dependence of photo emission on
(a) frequency of light **(b)** speed of light
(c) threshold frequency of light **(d)** none of these

(80) The relation $hf-\phi=\frac{1}{2}mv^2{}_{max}$ called
(a) Einstein's photoelectric equation **(b)** Compton's photoelectric equation
(c) Stefen's photoelectric equation **(d)** Wein's photoelectric equation

(81) Albert Einstein was awarded Noble prize in physics in
(a) 1921 **(b)** 1821
(c) 1930 **(d)** 1956

(82) In photoelectric effect, the threshold frequency is
(a) different for different materials **(b)** same for all material
(c) neither different nor same **(d)** small for all materials

(83) In Compton scattering the change in the wavelength is given by
(a) $\Delta\lambda=\frac{h}{m_oc^2}(1+cos\theta)$ **(b)** $\Delta\lambda=\frac{h}{m_oc^2}(1-cos\theta)$
(c) $\Delta\lambda=\frac{hc}{m_o}(1-cos\theta)$ **(d)** $\Delta\lambda=\frac{h}{m_oc}(1-cos\theta)$

(84) In Compton scattering the change in wavelength will be maximum if
(a) angle of scattering is 90^0 **(b)** angle of scattering is 60^0
(c) angel of scattering is 45^0 **(d)** angle of scattering is 180^0

(85) The factor $\frac{h}{m_oc}$ has dimension of
(a) mass **(b)** length
(c) time **(d)** frequency

(86) Compton was awarded Nobel prize in physics in
(a) 1921 **(b)** 1927
(c) 1827 **(d)** 1980

(87) The value of $\frac{h}{m_o c}$ is
(a) 2.43×10^{-12}m (b) 2.43×10^{-2}km
(c) 2.43×10^{-12}km (d) 2.43×10^{-16}m

(88) A positron is a particle having mass equal and charge opposite to
(a) electron (b) neutron
(c) proton (d) meson

(89) The sum of rest mass energy of electron and positron is equal to
(a) 1.02 MeV (b) 0.511 MeV
(c) 1MeV (d) 5MeV

(90) Sodium and potassium cathode emits
(a) electrons for violet light (b) electrons for visible light
(c) protons for infrared light (d) electrons for infrared light

(91) Cesium coated oxidation silver emits
(a) electrons for violet light (b) electrons for visible light
(c) electrons for ultra violet light (d) electrons for infrared light

(92) The photo cells are used to operate
(a) automatic street lighting (b) counting system
(c) security system (d) all of these

(93) Photo electric effect shows
(a) wave nature of light (b) electromagnetic nature of light
(c) corpuscular theory of light (d) dual nature of light

(94) The photo electric effect can be explained by
(a) wave nature of light (b) electromagnetic nature of light
(c) special theory of relativity (d) quantum theory of light

(95) If the scattered X-ray photons are observed at $\theta = 90°$ the Compton shift $\Delta\lambda$
(a) greater than Compton wavelength (b) is zero
(c) equals the Compton wavelength (d) less than Compton wavelength

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(96) The factor $\frac{h}{m_o c}$ in Compton effect has the dimensions of: **LHR-2017 (G-I), MTN-2019 (G-II)**
(a) pressure (b) length
(c) mass (d) momentum

(97) The unit of work function is: **GRW-2019 (G-I), SGD-2022 (G-II)**
(a) volt (b) joule
(c) watt (d) farad

(98) Albert Einstein was awarded Nobel Prize in physics in: **LHR-2021 (G-I)**
(a) 1905 (b) 1911
(c) 1916 (d) 1921

(99) The rest mass energy of an electron positron pair is: **LHR-2021 (G-II)**
(a) 0.51 Mev (b) 1.02 Mev
(c) 1.2 Mev (d) 1.00 Mev

(100) The rest mass of photon is **DGK-2017 (G-I), SGD-2017 (G-II), SGD-2022 (G-I)**
(a) 9.1×10^{-31}kg (b) 1.67×10^{-27}kg
(c) Infinite (d) zero

(101) The materialization of energy takes place in the process of: **SGD-2022 (G-I)**
(a) photoelectric effect (b) Compton effect

(c) pair production **(d)** Annihilation of matter

(102) Compton's shift will be maximum at the angle of. SGD-2022 (G-II)

(a) 90° **(b)** 180°

(c) 360° **(d)** 60°

(103) Rest mass energy of electron is DGK-2017 (G-I)

(a) 1.02 MeV **(b)** 0.51 MeV

(c) 931 MeV **(d)** 200 MeV

(104) The Compton shift $\Delta\lambda$ is equal to Compton wavelength at an angle of DGK-2017 (G-II)

(a) 0° **(b)** 120°

(c) 45° **(d)** 90°

(105) Compton wavelength is: MTN-2019, 2022 (G-I)

(a) $\frac{h}{m_o c^2}$ **(b)** $\frac{hc}{m_o}$

(c) $\frac{h}{m_o c}$ **(d)** $\frac{hc}{m_o \lambda}$

(106) The energy required for pair production is: MTN-2019, 2022 (G-I)

(a) 0.51 MeV **(b)** 1.02 MeV

(c) 2.04 MeV **(d)** 3.06 MeV

(107) Compton effect is associated with: LHR-2022 (G-I)

(a) gamma rays **(b)** Beta rays

(c) X-rays **(d)** Positive rays

(108) $\frac{h}{m_o c}$ has the unit of: FSD-2022 (G-I)

(a) pressure **(b)** length

(c) mass **(d)** momentum

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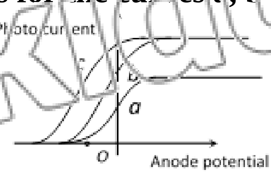
(109) Light of frequency 1.5 times the threshold frequency is incident on a photo sensitive material. If the
frequency is halved and intensity is doubled the photo electric current becomes

(a) Four times **(b)** Double

(c) Half **(d)** Zero

(110) The figure shows the variation of photocurrent with anode potential for a photo sensitive surface for three different radiations. Let I_a, I_b and I_c be the intensities and f_a, f_b and f_c be the frequencies for the curves a, b and c respectively



(a) $f_a = f_b$ and $I_a \neq I_b$ **(b)** $f_a = f_c$ and $I_a = I_c$

(c) $f_a = f_b$ and $I_a = I_b$ **(d)** $f_a = f_b$ and $I_a = I_b$

(111) A photon of energy 3.4eV is incident on a metal having work function 2eV. The maximum K.E of photo-electron is equal to

(a) 1.4 eV **(b)** 1.7eV

(c) 5.4 eV **(d)** 6.8 eV

(112) Compton shift is Maximum when θ is
(a) 40° (b) 0°
(c) 180° (d) 45°

Topic 19.6:

Annihilation of Matter

(113) The pair production and annihilation of matter are:
(a) similar phenomena (b) opposite to each other
(c) both of these (d) none of these

(114) In annihilation of matter, positron and electron pair disappears into two:
(a) α - particles (b) β - particles
(c) γ - ray photons (d) none of these

(115) When an electron comes in contact with a positron, they are annihilated according to the relation:
(a) $e^+ - e^- \rightarrow \gamma + \gamma$ (b) $e^+ + e^- \rightarrow \gamma$
(c) $e^- - e^- \rightarrow \gamma + \gamma$ (d) $e^+ + e^- \rightarrow \gamma + \gamma$

(116) The existence of positron was predicted by
(a) Compton (b) Dirac
(c) De Broglie (d) Heisenberg

(117) In pair production two photons are produced which are traveling in opposite directions so that
(a) energy is conserved (b) mass is conserved
(c) momentum is conserved (d) charge is conserved

(118) The Positron was discovered in the cosmic radiation by
(a) Thomson (b) Anderson
(c) Millikan (d) Chadwick

(119) The existence of positron was predicted by Dirac in:
(a) 1922 (b) 1924
(c) 1926 (d) 1928

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(120) The existence of Positron was predicted by: **BWP-2019 (G-II)**
(a) G.P. Thomson (b) Dirac
(c) Germer (d) Newton

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(121) When an electron comes in contact with a positron, they are annihilated according to the relation:
(a) $e^+ - e^- \rightarrow \gamma + \gamma$ (b) $e^+ + e^- \rightarrow \gamma$
(c) $e^- - e^- \rightarrow \gamma + \gamma$ (d) $e^+ + e^- \rightarrow \gamma + \gamma$

Topic 19.7:

Wave Nature of Particles

(122) Louis de-Broglie wavelength of a particle can be expressed by:
(a) $\lambda = \frac{p}{h}$ (b) $\lambda = \frac{h}{p}$
(c) $\lambda = \frac{h}{mc}$ (d) none of these

(123) According to De-Broglie, an electron can be regarded as:

(a) particle only (b) are negligible
(c) particle and wave both (d) none of these

(124) The wavelength of x-rays is of the order of:
(a) 10^{-8}m (b) 10^{-9}m
(c) 10^{-10}m (d) 10^{-12}m

(125) De-Broglie's hypothesis of wave nature of electrons was confirmed experimentally by:
(a) Lummer and Pringsheim (b) Davisson and Germer
(c) Einstein and Max Planks (d) photoelectric equation

(126) Davisson determine the wavelength of scattered electron from the relation:
(a) $\lambda = \frac{h}{2mVe}$ (b) $\lambda = \frac{h}{2\sqrt{2mVe}}$
(c) $\lambda = \frac{2h}{\sqrt{mVe}}$ (d) $\lambda = \frac{h}{\sqrt{2mVe}}$

(127) If an electron is accelerated through a potential difference of 54 volts, its de-Broglie wavelength will be:
(a) 1.66×10^{-8}m (b) 1.66×10^{-9}m
(c) 1.66×10^{-10}m (d) 1.66×10^{-12}m

(128) Electron microscope makes practical use of the:
(a) particle nature of electrons (b) wave nature of electrons
(c) dual nature of electrons (d) none of these

(129) The Davison and Germer experiment indicates
(a) interference (b) polarization
(c) electron diffraction (d) refraction

(130) In Davisson and Germer experiment, target crystal is made up of
(a) copper (b) aluminium
(c) nickle (d) silver

(131) Interference and diffraction of light confirm its
(a) particle nature of light (b) wave nature of light
(c) dual nature of light (d) electromagnetic nature of light

(132) Prince Louis Victor de Broglie received Nobel prize in
(a) 1929 (b) 1981
(c) 1939 (d) 1829

(133) Light behaves as a stream of
(a) protons (b) electrons
(c) photons (d) positrons

(134) A three dimensional image of remarkable quality can be achieved by modern versions called
(a) scanning electron microscope (b) scanning proton microscope
(c) scanning electron telescope (d) scanning electron spectrometer

(135) Which of the given is an antiparticle of electron
(a) meson (b) positron
(c) photon (d) neutron

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(136) Wave nature of light appears in **GRW-2019 (G-II)**
(a) pair production (b) compton effect
(c) photoelectric (d) interference

(137) If the following particles have the same energy which particle has the shortest wave length **SWL-2017**

(a) α–particle **(b)** neutron
(c) β–particle **(d)** proton

(138) The most refined form of Matter by de Broglie is: **BWP-2019 (G-II)**

(a) Smoke **(b)** Fog
(c) Light **(d)** Protons

(139) Diffraction of electron indicates **MTN-2022 (G-II)**

(a) wave nature **(b)** particle nature
(c) dual nature **(d)** crystal nature

(140) de Broglie wavelength of moving cricket ball is not noticed due to **MTN-2022 (G-II)**

(a) low mass **(b)** high speed
(c) time delay **(d)** low speed

(141) An electron moving with speed of 1×10^{6} ms^{-1} has wavelength: **FSD-2022 (G-I)**

(a) 7×10^{-10}m **(b)** 7×10^{-12}m
(c) 1×10^{-10}m **(d)** 7×10^{10}m

ENTRY TEST MCQS

(142) Which one is the correct expression of de Broglie equation for the wave length of atoms of mass m at temperature T (k = Boltzmann constant)?

(a) $\lambda = \dfrac{h}{3mk}$ **(b)** $\dfrac{h}{\sqrt{3kTm}}$
(c) $\dfrac{h}{3kTm}$ **(d)** $\lambda = \dfrac{h}{\sqrt{3kT}}$

(143) A three-dimensional image of remarkable quality can be achieved by modern versions called:

(a) Scanning electron microscope **(b)** Scanning proton microscope
(c) Scanning electron telescope **(d)** Scanning electron spectrometer

(144) λ is proportional to

(a) $\dfrac{1}{E}$ for both photons and particles **(b)** $\dfrac{1}{E}$ for photons and $\dfrac{1}{\sqrt{E}}$ for particles
(c) $\dfrac{1}{\sqrt{E}}$ for both photons and particles **(d)** $\dfrac{1}{\sqrt{E}}$ for photons and $\dfrac{1}{E}$ for particles

Topic 19.8:

Uncertainty Principle

(145) According to Heisenberg's principle, the product of uncertainty Δx in the position of particle at some instant and the uncertainty Δp in the x component of momentum at the same instant approximately equal to

(a) Boltzmann constant **(b)** Planck's constant
(c) Davisson and Germen principle **(d)** Uncertainty principle

(146) In the subatomic world few things can be predicted with

(a) 50% precision **(b)** 100% precision

(c) 75% precision **(d)** 90% precision

(147) The uncertainty in the position and momentum can be written as:

(a) $\Delta x.\ \Delta p \approx h$ **(b)** $\Delta x.\ \frac{1}{\Delta p} \approx n$

(c) $\Delta p.\ \frac{1}{\Delta x} \approx h$ **(d)** $\Delta x.\ \Delta p \approx \frac{1}{\Delta h}$

(148) The form of uncertainty principle which relates the energy of a particle and the time at which it had the energy is given by:

(a) $\Delta E.h \approx \Delta t$ **(b)** $\Delta E.\ \Delta t \approx 2h$

(c) $\Delta E.\ \Delta p \approx n$ **(d)** $\Delta E.\ \Delta t \approx h$

(149) Heisenberg uncertainty principle was proposed in:

(a) 1921 **(b)** 1927

(c) 1937 **(d)** 1932

PAST PAPER MCQS

(150) The life time of an electron in an excited state is about 10-8s. What is its uncertainty in energy during this time: LHR-2019 (G-II)

(a) 6.63×10^{-34} J **(b)** 9.1×10^{-31} J

(c) 1.05×10^{-26} J **(d)** 7.2×10^{-15} J

(151) The value of $\hbar$ (e.g. in Heisenberg uncertainty principle) is; MIRPUR (AJK) 2017

(a) 1.05×10^{-30} Js **(b)** 1.05×10^{-32} Js

(c) 1.05×10^{-34} Js **(d)** 1.05×10^{-36} Js

ENTRY TEST MCQS

(152) In Heisenberg Principle:

(a) Position and momentum cannot be measured accurately of sub-atomic particles

(b) Position and momentum cannot be measured accurately of electrons

(c) Position and momentum can be measured accurately of electrons

(d) Position and momentum can be measured accurately of sub-atomic particles

ANSWER KEYS

(Topical Multiple Choice Questions)

1	B	21	B	41	D	61	A	81	A	101	C	121	D	141	C
2	A	22	C	42	B	62	B	82	A	102	B	122	B	142	B
3	B	23	B	43	C	63	B	83	D	103	B	123	C	143	A
4	B	24	C	44	A	64	C	84	D	104	D	124	C	144	B
5	A	25	A	45	D	65	D	85	B	105	C	125	B	145	B
6	A	26	B	46	C	66	B	86	B	106	B	126	D	146	B
7	A	27	D	47	C	67	C	87	A	107	C	127	C	147	A
8	A	28	A	48	B	68	B	88	A	108	B	128	B	148	D
9	B	29	C	49	C	69	C	89	A	109	D	129	C	149	B
10	D	30	D	50	A	70	B	90	B	110	A	130	C	150	C
11	A	31	D	51	A	71	A	91	D	111	A	131	B	151	C
12	B	32	B	52	C	72	C	92	D	112	C	132	A	152	A
13	B	33	D	53	A	73	D	93	C	113	B	133	C		
14	C	34	C	54	A	74	B	94	D	114	C	134	A		
15	C	35	B	55	B	75	A	95	C	115	D	135	B		
16	C	36	B	56	B	76	D	96	B	116	B	136	D		
17	C	37	C	57	B	77	B	97	B	117	C	137	A		
18	A	38	C	58	A	78	B	98	D	118	B	138	C		
19	C	39	D	59	B	79	C	99	A	119	D	139	A		
20	A	40	C	60	B	80	A	100	D	120	B	140	D		

KIPS TOPICAL SHORT QUESTIONS

19.1, 19.2 RELATIVE MOTION, INERTIAL FRAME OF REFERENCE

(1) Define relative motion.

Ans: **Relation Motion:** Anything is moving or not, all this depends on the state of observer, and the ideas which are stated with reference to some other things are called relative. Hence,

"Relative motion means motion of everything with reference to some other object."

(2) Differentiate between inertial & non-inertial frame of reference.

Ans:

Inertial Frame of Reference	Non-inertial Frame of Reference
i. A frame of reference which is either at rest or moving with constant velocity is inertial.	**i.** A frame of reference which is moving with non uniform velocity is non inertial.
ii. Laws of motion are valid in inertial frame of reference.	**ii.** Laws of motion are not valid in non inertial frame of reference.
iii. A frame of reference having zero acceleration is inertial.	**iii.** A frame of reference having non zero acceleration is non inertial.
iv. A class room and car moving with constant velocity are examples of inertial frame of reference.	**iv.** A car and bus moving with non uniform velocity are examples of non inertial frame of reference.
v. It is non-accelerated frame.	**v.** It is accelerated frame.

(3) What is a frame of reference?

Ans: A frame of reference is any coordinate system relative to which measurements are taken.
In space, a frame of reference consists of three mutually perpendicular axes fixed on the earth. The position of an object in space is expressed by a set of Cartesian co-ordinates namely x-axis y-axis and z-axis.

(4) Define frame of reference and differentiate an inertial frame from a non-inertial frame.

Ans: **Frame of Reference**

A co-ordinate system with reference to which we can take our observations is known as frame of reference.

Inertial Frame

A frame of reference at rest or moving with uniform velocity is known as an inertial frame of reference.

Non inertial frame

An accelerating frame of reference is known as non-inertial frame of reference.

(5) A satellite is orbiting around earth. Is its frame of reference inertial or non-inertial? Justify your answer.

Ans: **"**A satellite orbiting the earth is a non-inertial frame of reference."

Justification: An inertial frame requires velocity vector $\vec{v}$ to remain constant; in the case of orbiting satellite this vector is never constant. Hence satellite orbiting the earth is a non-inertial frame of reference.

PAST PAPER SHORT QUESTIONS

(6) What are the measurements on which two observers in relative motion will always agree upon? **LHR-2017 (G-I), BWP-2017 (G-I)**

(7) What is NAVSTAR navigation system? **DGK-2017 (G-I), LHR-2022 (G-I), FSD-2022 (G-II)**

(8) What is difference between inertial & non-inertial frame of reference. **MTN-2022 (G-I)**

(9) Rest and motion are not absolute but relative. Explain this statement with example.
BWP-2022 (G-II)

19.3 SPECIAL THEORY OF RELATIVITY

(10) What is the practical application of the results of the special theory?

Ans: Its practical application is NAVSTAR navigation system. With the help of this system, position and speed of aircraft can be found to an accuracy of about 2 cms^{-1} and 50 m respectively. Using this result, the location of any aircraft after an hour flight can be predicted to about 50m as compared to about 760 m determined without using relativistic effects.

(11) Give some important results drawn from Einstein's theory of relativity?

Ans: **(i)** According to Einstein's theory of relativity

$$m = \frac{m_o}{\sqrt{1-\frac{v^2}{c^2}}}$$

And $$\ell = \ell_o\sqrt{1-\frac{v^2}{c^2}}$$

Also $$t = \frac{t_o}{\sqrt{1-\frac{v^2}{c^2}}}$$

According to these results we can conclude that

(i) If speed of object approaches to speed of light, then mass becomes infinite

(ii) At speed, comparable to that of light, length contraction takes place along the direction of motion.

(iii) In moving frame, which is moving relative to speed of light, clock runs slower than normal clock.

(12) Differentiate between special theory of relativity and general theory of relativity.

Ans: **Special Theory of Relativity**

It deals with inertial frame of reference. This theory treats problems involving inertial or non-accelerating frames of reference.

In special theory of relativity, gravitational field does not play any part.

General Theory of Relativity

It deals with non-inertial or accelerating frame of reference. This theory treats problems relating to frames of reference accelerating with respect to one another.

(13) If applied force is increased, can an object move with the speed of light?

Ans: No, because by doing so $c \approx v$. Hence,

$$m = \frac{m_o}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{m_o}{\sqrt{1-\frac{c^2}{c^2}}} = \frac{m_o}{o} = \infty$$

But infinite mass is impossible. Hence, speed of light is not achieved.

(14) What the rest mass of photon be zero?

Ans: As $$m = \frac{m_o}{\sqrt{1-v^2/c^2}} \Rightarrow m_o = m\sqrt{1-\frac{v^2}{c^2}}$$

So, with rest mass m_o, photon must move with v = c.

$$m_o = m\sqrt{1-\frac{c^2}{c^2}} \Rightarrow m_o = m\sqrt{1-1}$$

$$\Rightarrow m_o = m(0) = 0$$

Hence, moving mass of photon becomes infinite and its energy becomes infinite too. As we know that energy of photon is not infinite, Hence, it rest mass must be zero.

(15) Speed of material object can never exceed speed of light why?

Ans: Suppose speed of material object is equal to speed of light i.e v = c

Then its mass can be calculated as

$$m = \frac{m_o}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{m_o}{\sqrt{1-\frac{c^2}{c^2}}} = \frac{m_o}{\sqrt{1-1}} = \frac{m_o}{o} = \infty$$

Multiplying both side by acceleration 'a' so

ma = (∞) **(a)**

F = ∞

This shows that infinity force is required to accelerate the object up to speed of light which is physically impossible. Hence speed of material object is always less than speed of light.

(16) What do you mean by E = mc^2?

Ans: By E = mc^2, we mean that mass is convertible to energy and energy can be converted to mass. In other words, we can say that mass is highly concentrated form of energy.

(17) What is NAVSTAR navigation system?

Ans: The results of special theory of relativity are put to practical use even in everyday life by a modern system of navigation satellites called NAVSTAR.

The location and speed anywhere on Earth can now be determined to an accuracy of about 2 cms^{-1}. If relativity effects are not taken into account, speed could not be determined any closer than about 20cms^{-1}. Using these results the location of an aircraft after an hour's flight can be predicated to about 50m as compared to about 760 m determined by without using relativistic effects.

(18) A body having rest time $t_\circ = 3.0\text{s}$ is moving with the velocity of 0.95c. Find the value of its relativistic time t.

Ans: $t_o = 3.0\text{s}$, $v = 0.95c$, $t = ?$

Using $$t = \frac{t_o}{\sqrt{1-\frac{v^2}{c^2}}}$$

$$t = \frac{3.0\text{s}}{\sqrt{1-\frac{(0.95c)^2}{c^2}}} = \frac{3.0\text{s}}{\sqrt{1-(0.95)^2}} = \mathbf{9.6s}$$

(19) Write two postulates of special theory of relativity?

Ans: **(i)** Physical laws are identical in all non accelerated (inertial) frames.

(ii) The speed 'c' of light in vacuum is constant throughout the universe and independent of speed of the observer or source. On the basis of these postulates the following results can be deduced.

(20) What is energy of a photon in joules, if its wavelength is 1240 nm?
(h = 6.63 × 10^{-34} Js, c=3 × 10^{8} ms^{-1})

Ans: $\lambda = 1240\,\text{nm}$, E=?

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

$$E = \frac{6.63\times10^{-34}\,\text{Js}\times3\times10^{8}\,\text{ms}^{-1}}{1240\times10^{-9}\,\text{m}} = 1.6\times10^{-19}\,\text{J}$$

$\mathbf{E = 1.0\,eV}$ **Ans.**

PAST PAPER SHORT QUESTIONS

(21) Write two postulates of special theory of relativity? **GRW-2019 (G-II), 2022 (G-I)**

(22) Does the dilation means that time really passes more slowly in moving system or that it only seems to pass more slowly? **MIRPUR (AJK) 2017**

(23) If the speed of light were infinite, what would be the equations of special theory of relativity reduce to? **SWL-2017, FSD-2022 (G-I)**

(24) Define special theory of relativity and write its postulate? **DGK-2022 (G-I)**

(25) If an object moves with speed of light, what will be its mass? Explain with equation. **BWP-2022 (G-II)**

(26) Find the mass m of a moving object with speed 0.8c. **RWP-2022 (G-II)**

19.4 BLACK BODY RADIATION

(27) What happens to total radiations from a blackbody if its absolute temperature is doubled?

Ans: According to Stefan – Boltzmann's law,

$E = \sigma T^4$

When the temperature is increased to double of its value, then

$E = \sigma(2T)4$

Or $E = \sigma \times 16T^4$

$E = 16\sigma T^4 = 16\,E$

Thus, the total radiation energy E' will increase 16 times.

(28) The rest mass of a photon is zero. What can you say about its momentum? Explain the reason.

Ans: Momentum of Photon

In the special theory of relativity, rest mass being zero does not imply that momentum of the photon will be zero. It is non-zero, and is equal to the following value:

$p = \frac{hf}{c}$ OR $p = \frac{h}{\lambda}$

Reason for this non-zero photon is that photon is never found at rest.

(29) What is the energy of quanta in eV having wavelength λ = 400 nm? (h = 6.63 × 10^{-34} J.s)

Ans: $\lambda = 400\,\text{nm}$, E=?

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

$$E = \frac{6.63\times10^{-34}\,\text{Js}\times3\times10^{8}\,\text{ms}^{-1}}{400\times10^{-9}\,\text{m}} = 4.9\times10^{-19}\,\text{J}$$

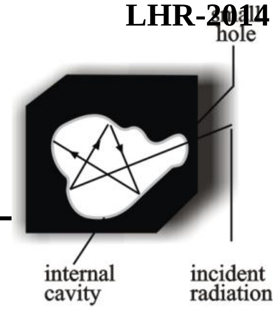
$\mathbf{E = 3.0\,eV}$

(30) Why is a cavity radiator considered as a black body? **LHR-2014**

Ans: Black Body

A hypothetical body which absorbs all kind of radiations when it is cold and emits all kind of radiation when it is hot is known as a black body.

In practice no substance is an ideal black body. The practical



(b) Absorption of radiation

approximation of a black body is a solid that has a hollow cavity within it. It has a small hole and the radiation can enter or escape only through this hole.
The inside is blackened with lamp black to make it good absorber and a bad reflector. Any radiation entering the black body suffers multiple reflections and ultimately lies inside the cavity.

(31) Define Stefan Boltzmann Law for radiation. **SGD-2015**

Ans: Stefan Boltzmann Law states that area under each curve represents the total energy (E) radiated per second per square meter over all wavelengths at a particular temperature. It is found that area is directly proportional to the fourth power of kelvin temperature T.

Thus $E \propto T^4$

$E = \sigma T^4$

Where σ is called Stephen's constant. Its value is $5.67 \times 10^{-8}\ Wm^{-2}K^{-4}$ and the above relation is known as Stephen-Boltzmann Law.

(32) Prove $p = \frac{h}{\lambda}$.

Ans: Derivation:

E=hf

$E = mc^2$ … (i)

$E = hf$ … (ii)

Comparing eq. (i) and (ii)

$mc^2 = hf$

$mc = \frac{hf}{c}$

$\because v = f\lambda$

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

PAST PAPER SHORT QUESTIONS

(33) What are black body radiations? **GRW-2019 (G-I), LHR-2021 (G-II)**

(34) As a solid is heated and begins to glow, why does it first appear red? **SGD-2017 (G-II), LHR-2021 (G-I), MTN-2022 (G-I)**

(35) What happens to total radiation from a blackbody if its absolute temperature is doubled? **MIRPUR (AJK) 2017, LHR-2022 (G-I), BWP-2022 (G-I)**

(36) Which has lower energy quanta, radio wave or X-rays? **DGK-2017 (G-II)**

(37) State Stefen's Boltzmann law. Also write the value of Stefen's constant. **LHR-2022 (G-II)**

19.5 INTERACTION OF ELECTROMAGNETIC RADIATION WITH MATTER

(38) Write an equation for Compton's effect in terms of frequency?

Ans: The Compton relation is given by:

$$\Delta\lambda = \lambda_s - \lambda_i = \frac{h}{m_o c}(1-\cos\theta)$$

Dividing both sides by c

$$= \frac{\lambda_s}{c} - \frac{\lambda_i}{c} = \frac{h}{m_o c^2}(1-\cos\theta)$$

$$\frac{1}{f_s} = \frac{1}{f_i} + \frac{h}{m_o c^2}(1-\cos\theta)$$

which is the required equation

(39) What determines the number of photoelectrons emitted from a metal surface and their maximum kinetic energy?

Ans: Intensity of light determines the no. of photo-electrons and frequency of light determines the K.E of ejected electrons.

(40) Find Compton shift in the wavelength of a photon scattered at an angle of 90°?

Ans: As $\Delta\lambda = \frac{h}{m_o c}(1-\cos\theta)$

If $\theta = 90^o$

$\Delta\lambda = \frac{h}{m_o c}(1-\cos 90^o)$

$= \frac{h}{m_o c} = 2.43\times10^{-12}\, m$

(41) Write down two uses of photocell.

Ans:
1. Security systems
2. Counting systems
3. Automatic door systems
4. Automatic street lighting
5. Exposure meter for photography
6. Sound track of movies.

(42) What is maximum value of Compton's shift? How it is related to Compton's wavelength.

Ans: Compton's shift is obtained by

$$\Delta\lambda = \frac{h}{m_o c}(1-\cos\theta)$$

When photons are scattered at an angle of 180^o then

$$\Delta\lambda = \frac{h}{m_o c}(1-\cos 180^o) = \frac{h}{m_o c}(1-(-1))$$

$$\Delta\lambda = 2\frac{h}{m_o c}$$ (A maximum value of Compton's shift)

Above relation shows that maximum value of Compton's shift is two times of Compton's wavelength.

(43) Differentiate between photoelectric effect and compton effect.

Ans.

PHOTOELECTRIC EFFECT	COMPTON EFFECT
i. It is the phenomenon of emission of electrons from metal surface due to the incident photons (radiation).	**i.** It is the phenomenon of scattering of photons from loosely bounded electrons and scattered photon has increased wavelength.
ii. Photons are completely absorbed within the metal surface.	**ii.** Photons transfer partly their momentum and energy.
iii. Photons of visible light or ultraviolet region of electromagnetic spectrum are used.	**iii.** Photons of x-rays are used.

(44) Will higher frequency light eject greater number of electrons than low frequency light?

Ans: No the number of photoelectrons does not depend upon the frequency but depends upon the intensity of light. Therefore, high frequency light will not emit more electrons than a low frequency light. It means that both high and low frequency lights will emit the same number of electrons.

(45) What do you understand by work function and stopping potential (cut off)

Ans: Work Functions

The maximum energy required to eject an electron from any metallic surface is called its work function. The work function is different for different metals. It is generally denoted by ϕ.

Stopping potential (or cut off potential)

The external voltage used to stop ejected photoelectrons is called cut-off potential or stopping potential.

(46) Write important results of the photo-electric effect.

Ans: It has been found by experiments that

(i) No photo-electrons are emitted when the frequency of light is below the threshold frequency.
(ii) The speed of photoelectrons increases with the increase in frequency of the incident light.
(iii) The number of photo-electrons emitted is directly proportional to the intensity of the incident light.
(iv) The threshold frequency depends upon the nature of the metal.
(v) A beam of light of frequency slightly greater than the threshold frequency, however weak it may be, causes an immediate emission of electrons.

(47) Write a note on work function 'ϕ' of a metal.

Ans: The minimum energy required by the electron to escape from the metal surface is called work function of a metal. It is denoted by 'ϕ' which is given as

$$\phi = hf_o$$

If the energy of incident photon is sufficient the electron is ejected immediately from the metal surface. A part of the photon energy (work function) is used by the electron to break away from the metal and the rest appears as the kinetic energy of the electron. That is

Incident photo energy-work function = Maximum K.E. of photo-electron

Or $$hf - \phi = \frac{1}{2}mv^2_{max}$$

This is known as Einstein's photoelectric equation.

(48) What is meant by Compton's wavelength?

Ans: The term $\frac{h}{m_oc}$ in the Compton's scattering equation

$$\Delta\lambda = \frac{h}{m_oc}(1-\cos\theta)$$

Where $\frac{h}{m_oc}$ is called Compton wavelength.

By putting the values of h, m_o and c, its value is found to be

$$\frac{h}{m_oc} = \frac{6.63\times10^{-34}}{9.1\times10^{-31}\times3\times10^{8}} = 2.43\times10^{-12}\,m$$

Compton wavelength becomes equal to Compton shift $\Delta\lambda$ at an angle of 90^o.

(49) Discuss the minimum and maximum value of Compton's shift.

Ans: When angle of scattering is zero i.e. $\theta = 0^o$

then $$\Delta\lambda = \frac{h}{m_o c}(1-\cos\theta)$$

$$= \frac{h}{m_o c}(1-1)$$

$\Delta\lambda = 0$ (minimum value of Compton's shift)

When photons are scattering at angle of 180 i.e $\theta = 180^o$ then

$$\Delta\lambda = \frac{h}{m_o c}(1-\cos 180^o)$$

$$= \frac{h}{m_o c}(1-(-1))$$

$$= \frac{2h}{m_o c}$$ (a maximum value of Compton's shift)

(50) What is photocell? Write its two uses.

Ans: Principle:

A photocell is based on photoelectric effect.

Construction:

A simple photocell is shown in fig.1. It consists of an evacuated glass bulb with a thin anode rod and a cathode of an appropriate metal surface.

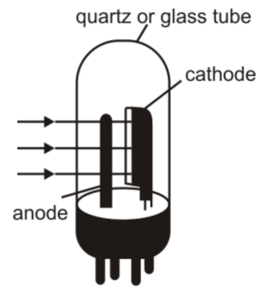


Fig.1

Uses:

1. Security systems
2. Counting systems
3. Automatic door systems
4. Automatic street lighting

(51) What is stopping potential?

Ans: If this potential is made more and more negative, at a certain value, called stopping potential V_0 the current becomes zero. Even the electrons of maximum energy are not able to reach collector plate. The maximum energy of photoelectrons is thus.

$$\frac{1}{2} mv^2_{max} = V_o e$$

(52) Define Compton Effect. At what angle Compton shift becomes equal to the Compton wave length?

Ans: It is the phenomenon of scattering of photons from loosely bounded electrons and scattered photon has increased wavelength.

If the angle is 90° then the Compton shift become equal to the Compton wavelength

As $$\Delta\lambda = \frac{h}{m_o c}(1-\cos\theta)$$

If $\theta = 90^o$

$$\Delta\lambda = \frac{h}{m_o c}(1-\cos 90^o)$$

$$= \frac{h}{m_o c} = 2.43\times10^{-12} m$$

(53) Define photoelectric effect and pair production.

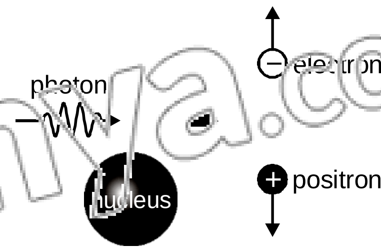
Ans: **Photoelectric effect**

It is phenomenon of emission of electrons from metal surface due to the incident photons (radiation).

Photons are completely absorbed with in metal surface.

Pair production

It is a kind of instruction of very high energy photon such as that of γ-rays with matter in which photon energy is changed into an electron – positron pair.



Pair Production

The interaction usually takes place in the electric field in the vicinity of a heavy nucleus as shown in the figure.

(54) What is condition of pair-production? Briefly explain

Ans: **Condition for Pair Production:**

For an electron or positron, the rest mass energy = $m_o c^2$ = 0.511MeV.

To create the two particles 2 × 0.511MeV or 1.02Mev energy is required.

For photons of energy greater than 1.02MeV, the probability of pair production occurrence increases as the energy increases and the surplus energy is carried off by the two particles in the form of kinetic energy.

The process can be represented by the equation.

Energy of photon = (Energy required for pair production) + (K.E of the particles)

$$\mathbf{hf = 2m_o c^2 + K.E.(e^-) + K.E.(e^+)}$$

PAST PAPER SHORT QUESTIONS

(55) Why can red light be used in a photographic dark room when developing films, but a blue or white light cannot? **LHR-2017 (G-I), DGK-2022 (G-II)**

(56) Which photon, red, green, or blue carries the most: (a) energy and (b) momentum? **DGK-2017 (G-I), LHR-2017 (G-I), LHR-2021 (G-II)**

(57) Define Compton effect. At what angle Compton shift becomes equal to the Compton wave length? **LHR-2019 (G-II), SGD-2017 (G-I)**

(58) Define Compton effect. Write its equation. **SGD-2017 (G-I)**

(59) Will bright light eject more electrons from a metal surface than dimmer light of the same color? **SGD-2017 (G-I), RWP-2022 (G-I), FSD-2022 (G-II)**

(60) Define photoelectric effect and pair production. **SGD-2017 (G-II)**

(61) Photon A has twice the energy of photon B. What is the ratio of the momentum of A to that of B? **MIRPUR (AJK) 2017, RWP-2022 (G-I)**

(62) Calculate the value of Compton wave length of photon. **FSD-2019 (G-I)**

(63) Write down four uses of photocell **SWL-2017, DGK-2022 (G-I)**

(64) When light shines on a surface, is momentum transferred to the metal surface. **SWL-2017, BWP-2022 (G-I)**

(65) Why don't we observe a Compton effect with visible light? **BWP-2017 (G-I), MTN-2022 (G-II), RWP-2022 (G-II), FSD-2022 (G-II)**

(66) What is condition of pair-production? Briefly explain **SWL-2019**

(67) Define Compton effect. Write formula of Compton shift for scattering angle θ. **BWP-2019 (G-II)**

(68) A beam of red light and beam of blue light have exactly the same energy. Which been contain the greater number of photon? **GRW-2022 (G-I)**

(69) Which has lower energy quanta? Radio waves and X-rays. **GRW-2022 (G-I, II), RWP-2022 (G-II)**

(70) Define threshold frequency and work function. Also give it unit. **MTN-2022 (G-II), DGK-2022 (G-I)**

(71) Compton shift ($\Delta\lambda$) in a wave in zero. Calculate the scattering angle of photon. **BWP-2022 (G-I)**

(72) Can pair production take place in vacuum? Explain. **BWP-2022 (G-I)**

19.6 ANNIHILATION OF MATTER

(73) Particle and its anti-particle co-exist? Explain?

Ans: No, whenever particle and antiparticle meet, they destroy each other. Hence these particles vanish and appear in the form of energy.

(74) Is gamma- ray photon produced in annihilation of matter, produce a pair of electron and positron?

Ans: No. As we know for the phenomenon of pair production γ – ray photon must have minimum energy of 1.02 MeV.

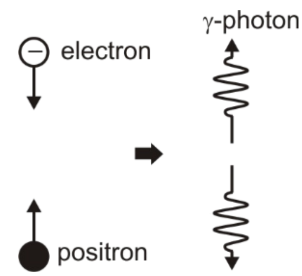
In annihilation of matter, photons produced have energy 0.51MeV which is smaller than 1.02 MeV i.e energy required to produce a pair of electron and positron.

(75) What do you mean by annihilation of matter?

Ans: It is the reverse process of pair production. When a particle and its antiparticle come close to each other, they annihilate or destroy each other. This process is known as annihilation of matter.

$$e^- + e^+ \rightarrow \gamma + \gamma$$

The two photons are produced traveling in opposite direction so that momentum is conserved this is shown in fig. Each photon has energy 0.51MeV equivalent to rest mass energy of a particle.



PAST PAPER SHORT QUESTIONS

(76) Is it possible to create a single electron from energy? Explain.

GRW-2022 (G-II), MTN-2022 (G-I), FSD-2022 (G-I)

19.7 WAVE NATURE OF PARTICLES

(77) What are the advantages of an electron microscope over optical microscope?

Ans:
(i) The resolving power of an electron microscope is thousand times greater than that of an optical microscope. Therefore, such minor details which cannot be seen by an optical microscope can be observed by an electron microscope.

(ii) A 50 kV electron microscope can resolve a distance 0.5 nm to 1 nm, whereas best optical microscope has the resolving power of 0.2 µm. This is the major advantage of electron microscope over optical microscope.

(iii) In an electron microscope, focusing of invisible electron beam can be done by electron and magnetic field instead of optical lens in an optical instrument.

(iv) The picture of internal structure of an object can be obtained with the help of electron microscope while an optical microscope is unable to do so.

(78) What is de-Broglie wavelength of a particle of mass 5.0 mg moving with 8 ms^{-1} ?
$(h = 6.63\times10^{-34}\,Js)$

Ans:
m= 5.0 mg= 5.0×10^{-6} kg
v= 8.0 ms^{-1}
h= 6.63×10^{-34} Js

Using $\lambda = \dfrac{h}{mc} = \dfrac{6.63\times10^{-34}\,Js}{5.0\times10^{-6}\,kg\times8.0\,ms^{-1}}$ **= 1.66×10^{-29} m**

(79) What is wave particle duality? Give its one practical use.

Ans: So we are forced to assume both wavelike and particles like properties for all matter: electrons, protons, neutrons, molecules etc. and also light, x-rays, γ-rays etc. have to be included in this.

In other words, matter and radiation have a dual wave-particle nature and this new concept is known as wave particle duality. The particles use is electron microscope.

(80) What is meant by De-Broglie hypothesis?

Ans: De-Broglie states that "when waves can behave like particles why should not particles behave like waves." And the wavelength associated to a particle of mass m, moving with velocity v is given by him,

$\lambda = \frac{h}{mv}$, where h is plank's constant.

This assumption was experimentally confirmed by Davison and Germer. According to this experiment, particles like electrons can show wave-like properties according to the proposal of De-Broglie.

(81) What is photon? Derive the relation between momentum of photon and wavelength of light?

Ans: **Photon:**

Einstein used the idea of quantization of energy proposed by Max Planck that light is emitted or absorbed in quanta, known as photons. Simply, small packets of energy are also called as photons. The energy of each photon of frequency f as given by quantum theory is

Derivation:

$$E = mc^2 \quad \ldots (i)$$

$$E = hf \quad \ldots (ii)$$

Comparing eq. (i) and (ii)

$$mc^2 = hf$$

$$mc = \frac{hf}{c}$$

$$\because v = f\lambda$$

$$p = \frac{h}{\lambda} \Rightarrow \frac{1}{\lambda} = \frac{f}{v}$$

PAST PAPER SHORT QUESTIONS

(82) What advantages an electron microscope has over an optical microscope?
SGD-2017 (G-II), LHR-2021 (G-I), MTN-2022 (G-II), DGK-2022 (G-II)

(83) If an electron and proton have the same de Broglie wavelength, which particle has greater speed? **BWP-2017 (G-I), LHR-2021 (G-II)**

(84) When does light behave as wave? When does it behave as a particle?
DGK-2017 (G-II), LHR-2022 (G-II)

(85) A particle of mass 5.0 mg moves with speed of 8.0 ms^{-1}. Calculate de-Broglie wave length. **MTN-2019 (G-I)**

(86) What is wave particle duality? Explain. **GRW-2022 (G-II)**

(87) Calculate the wavelength of an electron moving at 40 m/s. **DGK-2022 (G-II)**

(88) We do not notice de-Brogli wavelength for a pitched cricket ball. Explain why. **FSD-2022 (G-I)**

19.8 UNCERTAINTY PRINCIPLE

(89) Define positron and Heisenberg uncertainty principle?

Positron:

A positron is a particle having mass and charge equal in magnitude to that of electron but the charge being of opposite in nature i.e. positive.

The positron is also known as antiparticle of electron or anti-electron.

Heisenberg uncertainty principle:

This principle states that position and momentum of a particle cannot both be measured simultaneously with perfect accuracy.

(90) Write the two statements of uncertainty principle.

Ans: UNCERTAINTY PRINCIPLE:

Werner Heisenberg in 1927 proposed two principles:

i) Uncertainty in position (Δx) and momentum (Δp)

ii) Uncertainty in energy (ΔE) and time (Δt)

Uncertainty in position and momentum:

$$\Delta x . \Delta p \approx h$$

Either $\Delta x \approx \frac{h}{\Delta p}$ or $\Delta p \approx \frac{h}{\Delta x}$

i.e. position and momentum of an object cannot be measured simultaneously

Uncertainty in energy and time:

$$\Delta E . \Delta t \approx h$$

Either $\Delta E \approx \frac{h}{\Delta t}$ or $\Delta t \approx \frac{h}{\Delta E}$

(91) State uncertainty principle. Give its two mathematical forms.

Ans: This principle states that position and momentum of a particle cannot both be measured simultaneously with perfect accuracy.

Uncertainty in position and momentum:

$$\Delta x . \Delta p \approx h$$

Either $\Delta x \approx \frac{h}{\Delta p}$ or $\Delta p \approx \frac{h}{\Delta x}$

i.e. position and momentum of an object cannot be measured simultaneously

Uncertainty in energy and time:

$$\Delta E . \Delta t \approx h$$

Either $\Delta E \approx \frac{h}{\Delta t}$ or $\Delta t \approx \frac{h}{\Delta E}$

PAST PAPER SHORT QUESTIONS

(92) Define positron and Heisenberg uncertainty principle **RWP-2019 (G-I)**

(93) Explain uncertainty principle. **LHR-2022 (G-I)**