DAILY PRACTICE PROBLEM

Einstein's Quantum theory of Light DPP-01

1. Who discovered photo electric effect?

(1) Hertz
(2) Lenard
(3) Hallwach
(4) Einstein

2. The energy of a photon is equal to 3 kilo eV. Calculate its linear momentum?

(1) 1.6×10^{-24} kgm-s^{-1}
(2) 5.2×10^{-20} kgm-s^{-1}
(3) 7.6×10^{-22} kgm-s^{-1}
(4) 1.6×10^{-16} kgm-s^{-1}

3. Which of the following is incorrect statement regarding photon?

(1) Photon exerts no pressure
(2) Photon energy is hv
(3) Photon rest mass is zero
(4) None of these

4. Calculate number of photons passing through a ring of unit area in unit time if light of intensity 100 Wm^{-2} and of wavelength 400 nm is falling normally on the ring.

(1) 4.03×10^{15}
(2) 2.02×10^{20}
(3) 4.03×10^{10}
(4) 2.02×10^{10}

5. A TV station is operated at 100 MW with a signal frequency of 10 MHz. Calculate the number of photons radiated per second by its antenna.

(1) 1.5×10^{34} photons/sec
(2) 1.3×10^{33} photons/sec
(3) 1.3×10^{34} photons/sec
(4) 1.5×10^{33} photons/sec

6. Dual nature of radiation is shown by

(1) Diffraction and reflection
(2) Refraction and diffraction
(3) Photoelectric effect alone
(4) Photoelectric effect and diffraction

7. The De-Broglie wavelength λ

(1) is proportional to mass
(2) is proportional to impulse
(3) Inversely proportional to impulse
(4) does not depend on impulse

Answer key

Question	1	2	3	4	5	6	7
Answer	1	1	1	2	1	4	3

SOLUTIONS

1. **(1)**
Hertz

2. **(1)**
E = 3keV = 3000 eV
= $3000 \times 1.6 \times 10^{-19}$ J
= 4800×10^{-19} J = 48×10^{-17} J
$p = \frac{E}{c} = \frac{48\times10^{-17}}{3\times10^{8}} = 16 \times 10^{-25}$
$p = 1.6 \times 10^{-24}$ kgm-s^{-1}

3. **(1)**
Photon exerts no pressure

4. **(2)**
I = 100 W/m^2
λ = 400 nm
$I = \frac{n}{A}\frac{hc}{\lambda}$
$\frac{n}{A}$ = no. of photons per unit area per unit time
$\frac{n}{A} = \frac{I\lambda}{hc}$
$= \frac{100\times400\times10^{-9}}{6.6\times10^{-34}\times3\times10^{8}}$
$\frac{n}{A} = 2.02\times10^{20}$

5. **(1)**
P = 100 MW = 100×10^6 W = 10^8 W
ν = 10 MHz = 10^7 Hz
$\lambda = \frac{c}{\nu} = \frac{3\times10^{8}}{10^{7}}$ = 30 m
$n = 5 \times 10^{24} P\lambda$
$= 5 \times 10^{24} \times 10^8 \times 30$
$n = 15 \times 10^{33}$ photons/sec
$= 1.5 \times 10^{34}$ photons/sec

6. **(4)**
Photoelectric effect and diffraction

7. **(3)**
Inversely proportional to impulse

DAILY PRACTICE PROBLEM

Radiation Force and Pressure DPP-02

1. A parallel beam of monochromatic light of wave length 500 nm is incident normally on a perfectly absorbing surface. The power through any cross-section of the beam is 10 W. Find

(a) Number of photon absorbed by the surface per second.

(b) The force exerted by light beam on the surface.

(1) (a) 3.5×10^{10} photons/sec (b) 3.5×10^{-8} N
(2) (a) 2.5×10^{29} photons/sec (b) 2.3×10^{-8} N
(3) (a) 3.5×10^{19} photons/sec (b) 3.5×10^{-2} N
(4) (a) 2.5×10^{19} photons/sec (b) 3.3×10^{-8} N

2. A special kind of light bulb emits monochromatic light of wavelength 700 nm. Electrical energy supply to it at the rate of 60 W and the bulb is 50% efficient at converting that energy to light energy. How many photons are emitted by the bulb during its life time of 1 day.

(1) 5.070×10^{25}
(2) 9.072×10^{24}
(3) 3.070×10^{12}
(4) 4.072×10^{15}

3. When heat radiation falls on a surface then it:

(1) gives energy and exerts pressure
(2) gives energy but does not exerts pressure
(3) does not give energy but exerts pressure
(4) neither gives energy nor exerts pressure

4. A radio transmitter radiates 1 kW power at a wavelength 198.6 metres. How many photons does it emit per second

(1) 10^{10}
(2) 10^{20}
(3) 10^{30}
(4) 10^{40}

5. The pressure exerted by an electromagnetic wave of intensity I (W/m^2) on a non-reflecting surface is [c is the velocity of light]

(1) I/c
(2) Ic^2
(3) Ic
(4) I/c^2

Answer key

Question	1	2	3	4	5
Answer	4	2	1	3	1

SOLUTIONS

1. **(4)**

λ = 500 nm = 500 × 10^{-9} m = 5 × 10^{-7} m

P = 10 W

(a) n = 5 × 10^{24} Pλ $\left(P = n\frac{hc}{\lambda}\right)$

= 5 × 10^{24} × 10 × 5 × 10^{-7}

n = 25 × 10^{18} photons/sec

= 2.5 × 10^{19} photons/sec

(b) For perfectly absorbing surface –

F = $\frac{P}{c} = \frac{10}{3\times10^8} = 3.3\times10^{-8}$N

2. **(2)**

λ = 700 nm

P = 60 W

η = 50%

∵ Bulb efficiency in converting electrical energy to light energy is 50%

∵ Power radiated by bulb = $\frac{50}{100}\times60$ = 30W

No. of photons emitted per sec = n

n = 5 × 10^{24} × 700 × 10^{-9} × 30

n = 105 × 10^{18} photons/sec

Number of photons emitted in 1 day is

105 × 10^{18} × 3600 × 24 = 9.072 × 10^{24}

3. **(1)**

gives energy and exerts pressure

4. **(3)**

$$P = \frac{W}{t} = \frac{nhc}{\lambda t} \Rightarrow 10^3 = \frac{n\times6.6\times10^{-34}\times3\times10^8}{198.6\times1}$$

$$\Rightarrow n = 10^{30}$$

5. **(1)**

I/c

DAILY PRACTICE PROBLEM

Photoelectric Effect DPP-03

1. The work function of a metal is 4 eV if 5000Å wavelength of light is incident on the metal. Is there any photo electric effect?

(1) Both possible
(2) No
(3) Yes
(4) None of these

2. The wavelength of photons in two cases are 4000 Å and 3600 Å respectively what is difference in stopping potential for these two?

(1) 0.24 V
(2) 0.14 V
(3) 0.34 V
(4) 0.26 V

3. If the momentum of a photon is p, then its frequency is

(1) $\frac{ph}{c}$
(2) $\frac{pc}{h}$
(3) $\frac{mh}{c}$
(4) $\frac{mc}{h}$

4. The energy of a photon is $E = h\nu$ and the momentum of photon $p = \frac{h}{\lambda}$, then the velocity of photon will be

(1) E/p
(2) Ep
(3) $\left(\frac{E}{p}\right)^2$
(4) $3\times10^8 m/s$

5. The approximate wavelength of a photon of energy 2.48 eV is

(1) 500 Å
(2) 5000 Å
(3) 2000 Å
(4) 1000 Å

6. Wavelength of a 1 keV photon is 1.24×10^{-9} m. What is the frequency of 1 MeV photon

(1) 1.24×10^{15} Hz

(2) 2.4×10^{20} Hz

(3) 1.24×10^{18} Hz

(4) 2.4×10^{23} Hz

7. What is the momentum of a photon having frequency 1.5×10^{13} Hz

(1) 3.3×10^{-29} kg m/s

(2) 3.3×10^{-34} kg m/s

(3) 6.6×10^{-34} kg m/s

(4) 6.6×10^{-30} kg m/s

8. The energy of a photon of light of wavelength 450 nm is

(1) 4.4×10^{-19} J

(2) 2.5×10^{-19} J

(3) 1.25×10^{-17} J

(4) 2.5×10^{-17} J

9. Frequency of photon having energy 66 eV is

(1) 8×10^{-15} Hz

(2) 12×10^{-15} Hz

(3) 16×10^{15} Hz

(4) None of these

Answer key

Question	1	2	3	4	5	6	7	8	9
Answer	2	3	2	1	2	2	1	1	3

SOLUTIONS

1. **(2)**

ϕ = 4eV

λ = 5000 Å

$E = \frac{12400}{5000} = 2.48$ eV

$\because$ Energy of photon < ϕ

$\therefore$ photo electric effect does not occur.

2. **(3)**

$\lambda_1 = 4000\text{Å}$	$\lambda_2 = 3600\text{Å}$
$E_1 = \frac{12400}{4000} = 3.1\text{eV}$	$E_2 = 3.44\text{eV}$
$eV_{01} = E_1 - \phi$	$eV_{02} = E_2 - \phi$

$eV_{02} - eV_{01} = E_2 - E_1 = 3.44 - 3.1 = 0.34$ eV

$V_{02} - V_{01} = 0.34$ V

3. **(2)**

$$p = \frac{E}{c} = \frac{h\nu}{c} \Rightarrow \nu = \frac{pc}{h}$$

4. **(1)**

Momentum of photon $p = \frac{E}{c}$

$\Rightarrow$ Velocity of photon $c = \frac{E}{p}$

5. **(2)**

By using $E(\text{eV}) = \frac{12375}{\lambda(\text{Å})}$

$$\Rightarrow \lambda = \frac{12375}{2.48} = 4989.9\,\text{Å} \approx 5000\,\text{Å}$$

6. **(2)**

$$E = h\nu \Rightarrow \nu = \frac{E}{h} = \frac{1\times10^{6}\times1.6\times10^{-19}}{6.6\times10^{-34}}$$

$= 2.4\times10^{20}$ Hz

7. **(1)**

$$p = \frac{h\nu}{c} = \frac{6.6\times10^{-34}\times1.5\times10^{13}}{3\times10^{8}}$$

$$= 3.3\times10^{-29}\,\text{kg-m/sec}$$

8. **(1)**

$$E = \frac{hc}{\lambda} = \frac{6.62\times10^{-34}\times3\times10^{8}}{450\times10^{-9}}$$

$$= 4.4\times10^{-19}\,J$$

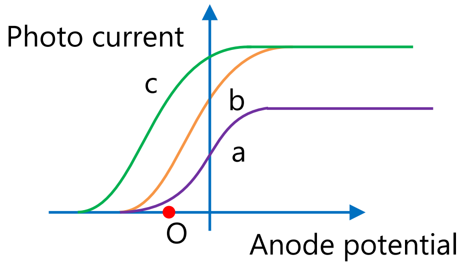
9. **(3)**

$$E = h\nu \Rightarrow \nu = \frac{E}{h} = \frac{66\times1.6\times10^{-19}}{6.6\times10^{-34}}$$

$$= 16\times10^{15}\,\text{Hz}$$

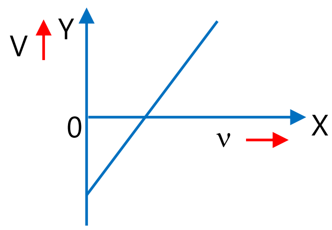
Observations of Lenard's Experiment of Photoelectric Effect DPP-04

1. **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**



(1) $f_a = f_b$ and $I_a \neq I_b$
(2) $f_a = f_c$ and $I_a = I_c$
(3) $f_a = f_b$ and $I_a = I_b$
(4) $f_a \neq f_b$ and $I_a = I_b$

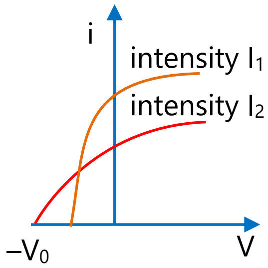
2. **The stopping potential V for photoelectric emission from a metal surface is plotted along Y-axis and frequency ν of incident light along X-axis. A straight line is obtained as shown. Planck's constant is given by**



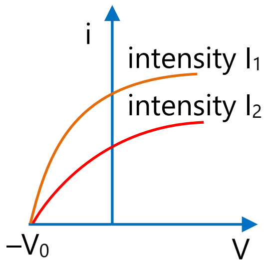
(1) Slope of the line
(2) Product of slope on the line and charge on the electron
(3) Product of intercept along Y-axis and mass of the electron
(4) Product of Slope and mass of electron

3. **The curves (a), (b) (c) and (d) show the variation between the applied potential difference (V) and the photoelectric current (i), at two different intensities of light ($I_1 > I_2$). In which figure is the correct variation shown**

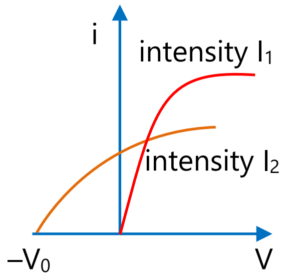
(1)



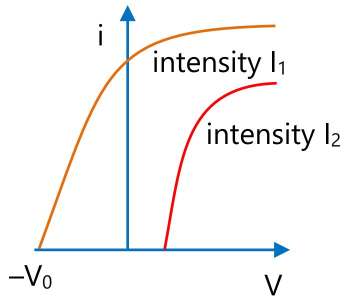
(2)



(3)



(4)



4. In photoelectric effect, the K.E. of electrons emitted from the metal surface depends upon

(1) Intensity of light
(2) Frequency of incident light
(3) Velocity of incident light
(4) Both intensity and velocity of light

5. The magnitude of saturation photoelectric current depends upon

(1) Frequency
(2) Intensity
(3) Work function
(4) Stopping potential

6. According to Einstein's photoelectric equation, the plot of the kinetic energy of the emitted photo electrons from a metal versus the frequency, of the incident radiation gives a straight line whose slope

(1) Is the same for all metals and independent of the intensity of the radiation
(2) Depends on the intensity of the radiation
(3) Depends both on the intensity of the radiation and the metal used
(4) Depends on the nature of the metals used

Answer key

Question	1	2	3	4	5	6
Answer	1	2	2	2	2	1

SOLUTIONS

1. **(1)**

The stopping potential for curves a and b is same.

$\therefore\ f_a = f_b$

Also saturation current is proportional to intensity

$\therefore\ I_a < I_b$

2. **(2)**

$K_{max} = h\nu - h\nu_0$

$\Rightarrow\ eV_0 = h\nu - h\nu_0$

$\Rightarrow\ V_0 = \frac{h}{e}\nu - \frac{h\nu_0}{e}$

Comparing this equation with $y = mx + c$, we get slope $m = \frac{h}{e} \Rightarrow\ h = m \times e$.

3. **(2)**

$I_1 > I_2$ (given) $\Rightarrow i_1 > i_2 \quad (\because i \propto I)$

and stopping potential does not depend upon intensity. So, its value will be same (V_0).

4. **(2)**

If frequency of incident light increases, kinetic energy of photoelectron also increases.

5. **(2)**

The value of saturation current depends on intensity. It is independent of stopping potential.

6. **(1)**

$h\nu = h\nu_0 + KE_{max}$

$\Rightarrow KE_{max} = h\nu - h\nu_0$

On comparing this equation with y = mx + c we m = h = get Universal constant

Einstein's Photoelectric Equation DPP-05

1. **The work function of a metal is 1.6 × 10^{-19} J. When the metal surface is illuminated by the light of wavelength 6400 Å, then the maximum kinetic energy of emitted photo-electrons will be (Planck's constant h = 6.4 × 10^{-34} Js)**

(1) 14×10^{-19} J

(2) 2.8×10^{-19} J

(3) 1.4×10^{-19} J

(4) 1.4×10^{-19} eV

2. **The work function for tungsten and sodium are 4.5 eV and 2.3 eV respectively. If the threshold wavelength λ for sodium is 5460Å, the value of λ for tungsten is**

(1) 5893Å

(2) 10683Å

(3) 2791Å

(4) 528Å

3. **A photon of energy 3.4 eV is incident on a metal having work function 2 eV. The maximum K.E. of photo-electrons is equal to**

(1) 1.4 eV

(2) 1.7 eV

(3) 5.4 eV

(4) 6.8 eV

4. **The work function of a metallic surface is 5.01 eV. The photo-electrons are emitted when light of wavelength 2000Å falls on it. The potential difference applied to stop the fastest photo-electrons is** $[\mathrm{h} = 4.14 \times 10^{-15}\ \mathrm{eV\,sec}]$

(1) 1.2 volts

(2) 2.24 volts

(3) 3.6 volts

(4) 4.8 volts

5. **In a photoelectric experiment for 4000 Å incident radiation, the potential difference to stop the ejection is 2 V. If the incident light is changed to 3000 Å, then the potential required to stop the ejection of electrons will be**

(1) 2 V

(2) Less than 2 V

(3) Zero

(4) Greater than 2 V

6. **Light of wavelength 4000 Å is incident on a sodium surface for which the threshold wave length of photo – electrons is 5420 Å. The work function of sodium is**

(1) 4.58 eV

(2) 2.29 eV

(3) 1.14 eV

(4) 0.57 eV

Answer key

Question	1	2	3	4	5	6
Answer	3	3	1	1	4	2

SOLUTIONS

1. **(3)**

$$K_{max} = \frac{hc}{\lambda} - W_0 = \frac{6.4\times10^{-34}\times3\times10^{8}}{6400\times10^{-10}} - 1.6\times10^{-19}$$

$$= 1.4\times10^{-19}\,J$$

2. **(3)**

Since $W_0 = \frac{hc}{\lambda_0}$; $\therefore \frac{(W_0)_T}{(W_0)_{Na}} = \frac{\lambda_{Na}}{\lambda_T}$

$$\lambda_T = \frac{\lambda_{Na}\times(W_0)_{Na}}{(W_0)_T}$$

$$= \frac{5460\times2.3}{4.5} = 2791\,Å$$

3. **(1)**

$$K_{max} = (E - W_0) = (3.4 - 2)\,eV = 1.4\,eV$$

4. **(1)**

Energy of incident light $E = \frac{12375}{2000} = 6.18\,eV$

According to relation $E = W_0 + eV_0$

$$\Rightarrow V_0 = \frac{(E-W_0)}{e} = \frac{(6.18\,eV - 5.01\,eV)}{e}$$

$$= 1.17\,V \approx 1.2\,V$$

5. **(4)**

According to Einstein's photoelectric equation

$$E = W_0 + K_{max} \Rightarrow V_0 = \frac{hc}{e}\left[\frac{1}{\lambda} - \frac{1}{\lambda_0}\right]$$

Hence if λ decreases V_0 increases.

6. **(2)**

$$W_0 = \frac{12375}{\lambda_0(Å)} = \frac{12375}{5420} = 2.28\,eV$$

DPP
DAILY PRACTICE PROBLEM

Matter Wave - de Broglie Hypothesis DPP-06

1. The de-Broglie wavelength associated with the particle of mass m moving with velocity v is

(1) h/mv
(2) mv/h
(3) mh/v
(4) m/hv

2. When the kinetic energy of an electron is increased, the wavelength of the associated wave will

(1) Increase
(2) Decrease
(3) Wavelength does not depend on the kinetic energy
(4) None of the above

3. An electron of mass m when accelerated through a potential difference V has de-Broglie wavelength λ. The de-Broglie wavelength associated with a proton of mass M accelerated through the same potential difference will be

(1) $\lambda \frac{m}{M}$
(2) $\lambda \sqrt{\frac{m}{M}}$
(3) $\lambda \frac{M}{m}$
(4) $\lambda \sqrt{\frac{M}{m}}$

4. A photon and an electron have equal energy E. $\lambda_{photon} / \lambda_{electron}$ is proportional to

(1) $\sqrt{E}$
(2) $1/\sqrt{E}$
(3) $1/E$
(4) Does not depend upon E

5. What is the effective mass of a photon having wavelength λ?

(1) $\frac{c\lambda}{h}$
(2) $\frac{h}{c\lambda}$
(3) $\frac{\lambda}{h}$
(4) $c\lambda$

Answer key

Question	1	2	3	4	5
Answer	1	2	2	2	2

SOLUTIONS

1. **(1)**

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

2. **(2)**

$$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mE}};\ \therefore \lambda \propto \frac{1}{\sqrt{E}}$$ (h and m = constant)

3. **(2)**

$$\lambda = \frac{h}{\sqrt{2mE}} \Rightarrow \lambda \propto \frac{1}{\sqrt{m}}$$ (E = same)

4. **(2)**

$$\lambda_{photon} = \frac{hc}{E}$$ and $$\lambda_{electron} = \frac{h}{\sqrt{2mE}}$$

$$\Rightarrow \frac{\lambda_{photon}}{\lambda_{electron}} = c\sqrt{\frac{2m}{E}}$$

$$\Rightarrow \frac{\lambda_{photon}}{\lambda_{electron}} \propto \frac{1}{\sqrt{E}}$$

5. **(2)**

$$E = mc^2$$

$$m = \frac{E}{c^2}$$

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

$$m = \frac{hc}{\lambda c^2} = \frac{h}{c\lambda}$$

de Broglie Wavelength of Charged Particle DPP-07

1. If the de-Broglie wavelengths for a proton and for α–particle are equal, then the ratio of their velocities will be

(1) 4 : 1
(2) 2 : 1
(3) 1 : 2
(4) 1 : 4

2. The de-Broglie wavelength λ associated with an electron having kinetic energy E is given by the expression

(1) $\frac{h}{\sqrt{2mE}}$
(2) $\frac{2h}{mE}$
(3) $2mhE$
(4) $\frac{2\sqrt{2mE}}{h}$

3. What is the de-Broglie wavelength of the α–particle accelerated through a potential difference V

(1) $\frac{0.287}{\sqrt{V}}$ Å
(2) $\frac{12.27}{\sqrt{V}}$ Å
(3) $\frac{0.101}{\sqrt{V}}$ Å
(4) $\frac{0.202}{\sqrt{V}}$ Å

4. The de-Broglie wavelength of an electron having   of energy is nearly
(1eV = 1.6×10^{-19} J, Mass of electron = 9×10^{-31} kg Plank's constant = 6.6×10^{-34} J-sec)

(1) 140 Å
(2) 0.14 Å
(3) 14 Å
(4) 1.4 Å

5. If particles are moving with same velocity, then maximum de-Broglie wavelength will be for

(1) Neutron
(2) Proton
(3) β–particle
(4) α–particle

6. The wavelength associated with an electron accelerated through a potential difference of 100 V is nearly

(1) 100 Å
(2) 123 Å
(3) 1.23 Å
(4) 0.123 Å

7. If the kinetic energy of a free electron doubles, its de-Broglie wavelength changes by the factor

(1) $\frac{1}{\sqrt{2}}$
(2) $\sqrt{2}$
(3) $\frac{1}{2}$
(4) 2

Answer key

Question	1	2	3	4	5	6	7
Answer	1	1	3	4	3	3	1

SOLUTIONS

1. **(1)**

$$\lambda = \frac{h}{m_1v_1} = \frac{h}{m_2v_2};\ \therefore\ \frac{v_1}{v_2} = \frac{m_2}{m_1} = \frac{4}{1}$$

2. **(1)**

$$\frac{1}{2}mv^2 = E \Rightarrow mv = \sqrt{2mE};\ \therefore\ \lambda = \frac{h}{mv} = \frac{h}{\sqrt{2mE}}$$

3. **(3)**

$$\lambda = \frac{h}{\sqrt{2mE}} = \frac{h}{\sqrt{2m_\alpha Q_\alpha V}}$$

On putting $Q_\alpha = 2\times1.6\times10^{-19}C$

$m_\alpha = 4m_p = 4\times1.67\times10^{-27}kg$

$\Rightarrow\ \lambda = \frac{0.101}{\sqrt{V}}\text{Å}$

4. **(4)**

$$\lambda = \frac{h}{\sqrt{2mE}} = \frac{6.6\times10^{-34}}{\sqrt{2\times9\times10^{-31}\times80\times1.6\times10^{-19}}}$$

$= 1.4\text{Å}$

5. **(3)**

$$\lambda = \frac{h}{mv} \Rightarrow \lambda \propto \frac{1}{m}$$

6. **(3)**

$$\lambda = \frac{h}{\sqrt{2mQV}} = \frac{6.6\times10^{-34}}{\sqrt{2\times9.1\times10^{-31}\times1.6\times10^{-19}\times100}}$$

$= 1.23\text{Å}$

7. **(1)**

$$\lambda = \frac{h}{\sqrt{2mE}} \Rightarrow \lambda \propto \frac{1}{\sqrt{E}}$$

de Broglie Wavelength Associated with Uncharged Particles DPP-08

1. **The de-Broglie wavelength of a neutron at 27°C is λ. What will be its wavelength at 927°C?**
   (1) $\frac{\lambda}{2}$
   (2) $\frac{\lambda}{3}$
   (3) $\frac{\lambda}{4}$
   (4) $\frac{\lambda}{9}$

2. **For moving ball of cricket, the correct statement about de-Broglie wavelength is**
   (1) It is not applicable for such big particle
   (2) $\frac{h}{\sqrt{2mE}}$
   (3) $\sqrt{\frac{h}{2mE}}$
   (4) $\frac{h}{2mE}$

3. **Photon and electron are given same energy $(10^{-20}J)$. Wavelength associated with photon and electron are λ_{Ph} and λ_{el} then correct statement will be**
   (1) $\lambda_{Ph} > \lambda_{el}$
   (2) $\lambda_{Ph} < \lambda_{el}$
   (3) $\lambda_{Ph} = \lambda_{el}$
   (4) $\frac{\lambda_{el}}{\lambda_{Ph}} = C$

4. **de-Broglie wavelength of a body of mass 1 kg moving with velocity of 2000 m/s is**
   (1) 3.32×10^{-27} Å
   (2) 1.5×10^{7} Å
   (3) 0.55×10^{-22} Å
   (4) None of these

5. **de-Broglie wavelength of a body of mass m and kinetic energy E is given by**
   (1) $\lambda = \frac{h}{mE}$
   (2) $\lambda = \frac{\sqrt{2mE}}{h}$
   (3) $\lambda = \frac{h}{2mE}$
   (4) $\lambda = \frac{h}{\sqrt{2mE}}$

6. Find the ratio of de Broglie wavelength of molecules of hydrogen and helium which are at temperatures 27°C and 127°C respectively.

(1) $\sqrt{\frac{8}{3}}$

(2) $\sqrt{\frac{2}{3}}$

(3) $\sqrt{\frac{3}{8}}$

(4) $\sqrt{\frac{4}{3}}$

Answer key

Question	1	2	3	4	5	6
Answer	1	2	1	1	4	1

SOLUTIONS

1. **(1)**

$$\lambda_{neutron} \propto \frac{1}{\sqrt{T}} \Rightarrow \frac{\lambda_1}{\lambda_2} = \sqrt{\frac{T_2}{T_1}}$$

$$\Rightarrow \frac{\lambda}{\lambda_2} = \sqrt{\frac{(273+927)}{(273+27)}} = \sqrt{\frac{1200}{300}} = 2$$

$$\Rightarrow \lambda_2 = \frac{\lambda}{2}.$$

2. **(2)**

3. **(1)**

Wavelength of photon will be greater than that of electron because mass of photon is less than that of electron $\Rightarrow \lambda_{ph} > \lambda_e$

4. **(1)**

$$\lambda = \frac{h}{mv} = \frac{6.6\times10^{-34}}{1\times2000} = 3.3\times10^{-37}\,m$$

$$= 3.3\times10^{-27}\,Å$$

5. **(4)**

6. **(1)**

$$\lambda = \frac{h}{mv} = \frac{h}{\sqrt{2mE}}$$

$$E = \frac{3}{2}kT$$

$$\therefore \lambda = \frac{h}{\sqrt{3mkT}}$$

$$\frac{\lambda_H}{\lambda_{He}} = \frac{\sqrt{M_{He}T_{He}}}{\sqrt{M_H T_H}}$$

$$= \sqrt{\frac{4\times(273+127)}{2\times(273+27)}} = \sqrt{\frac{8}{3}}$$

DAILY PRACTICE PROBLEM

Explanation of Bohr Quantisation Condition DPP-09

1. For the Bohr's first orbit of circumference 2πr, the de-Broglie wavelength of revolving electron will be

(1) $2\pi r$
(2) πr
(3) $\frac{1}{2\pi r}$
(4) $\frac{1}{4\pi r}$

2. When wavelength of incident photon is decreased then

(1) Velocity of emitted photo-electron decreases
(2) Velocity of emitted photoelectron increases
(3) Velocity of photoelectron do not charge
(4) Photo electric current increases

3. If the wavelength of light is 4000 Å, then the number of waves in 1 mm length will be

(1) 25
(2) 0.25
(3) 0.25×10^4
(4) 25×10^4

4. The De-Broglie wavelength associated with electrons revolving round the nucleus in a hydrogen atom in ground state, will be: -

(1) 0.3 Å
(2) 3.3 Å
(3) 6.62 Å
(4) 10 Å

5. The De Broglie wavelength of an electron in the first bohr orbit is: -

(1) Equal to the circumference of the first orbit
(2) Equal to twice the circumference of the first orbit
(3) Equal to half the circumference of the first orbit
(4) Equal to one fourth the circumference of first orbit

6. According to De Broglie, wavelength of electron in second orbit is 10–9 metre. Then the circumference of orbit is :–

(1) 10^{-9} m
(2) 2×10^{-9} m
(3) 3×10^{-9} m
(4) 4×10^{-9}m

Answer key

Question	1	2	3	4	5	6
Answer	1	2	3	2	1	2

SOLUTIONS

1. **(1)**

$mvr = \frac{nh}{2\pi}$ According to Bohr's theory

$\Rightarrow 2\pi r = n\left(\frac{h}{mv}\right) = n\lambda$ for n = 1, $\lambda = 2\pi r$

2. **(2)**

With decrease in wavelength of incident photons, energy of photoelectrons increases.

3. **(3)**

Number of waves $= \frac{10^{-3}}{4000 \times 10^{-10}} = 0.25 \times 10^4$

4. **(2)**

Energy in ground state = 13.6 eV

I^st^ method : $\lambda = \frac{h}{\sqrt{2mE}}$

$$= \frac{6.62 \times 10^{-34}}{\sqrt{2 \times 9.1 \times 10^{-31} \times 13.6 \times 1.6 \times 10^{-19}}}$$

$= 3.3 \times 10^{-10}$ m = 3.3 Å

II^nd^ method : $\lambda = \frac{12.27}{\sqrt{V}}$ Å

$\Rightarrow \lambda = \frac{12.27}{\sqrt{V}}$ Å = 3.3 Å

5. **(1)**

6. **(2)**