CHAPTER

25

Dual Nature of Radiation & Matter

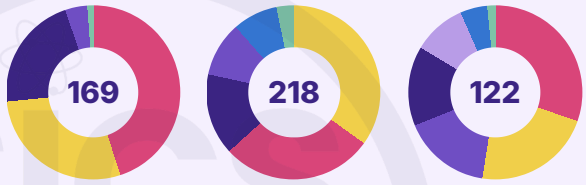
MHT CET · JEE · NEET Physics

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CONTENTS

25.1	Discharge, Cathode Rays & Thomson	2
25.2	Photons	7
25.3	Work Function & Einstein's Equation	10
25.4	Stopping Potential, Maximum Speed & KE Ratios	13
25.5	Effect of Intensity & Frequency	16
25.6	Graphs & Photocurrent	19
25.7	de Broglie Wavelength: Momentum, KE & Voltage	22
25.8	Thermal Particles; Photon against Electron	25
25.9	Fields, Bohr Orbits & Collisions	28
25.10	Davisson-Germer, Uncertainty, Compton & X-rays	31
★	**Exam-Day Card & Formula Sheet**	36

EXAM WEIGHTAGE



	CET	JEE	NEET
Photoelectric Effect: Einstein's Equation	76 (45%)	62 (28%)	37 (30%)
Matter Waves: de Broglie Wavelength	48 (28%)	76 (35%)	27 (22%)
Photoelectric Experiment: Intensity, Stopping Potential & Graphs	36 (21%)	33 (15%)	18 (15%)
Photons: Energy, Momentum & Radiation Pressure	7 (4%)	22 (10%)	20 (16%)
Davisson-Germer, Uncertainty, Compton & X-Rays	0 (0%)	18 (8%)	6 (5%)
Cathode Rays, Thomson's Experiment & Gas Discharge	0 (0%)	0 (0%)	12 (10%)
Other / Mixed: Atoms & Bohr Links	2 (1%)	7 (3%)	2 (2%)

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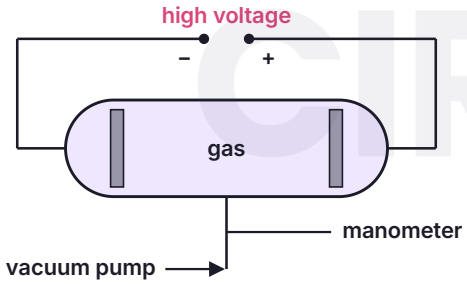
01 CONCEPT Discharge, Cathode Rays & Thomson

IN ONE LINE

At low pressure and high voltage a gas conducts, and the cathode gives out fast electrons called **cathode rays**.

25.1.1 Discharge through gases

- At normal pressure a gas is a poor conductor; about 30 kV is needed for a spark across a few cm of air.
- The tube is about 30 cm to 40 cm long and 4 cm in diameter.
- At low pressure the mean free path is larger, so electrons gain more KE between collisions.
- Fast electrons hit neutral atoms and **ionise** them.
- Coloured glow: charged particles from the cathode collide with gas atoms, and the excited atoms give out light.



Discharge tube with a vacuum pump

Pressure (mm of Hg)	What is seen
10	zig-zag spark, cracking sound
4	glow at the electrodes only (dark discharge)
below 4	positive column fills the tube
1.65	negative glow; Faraday's dark space
0.8	Crooke's dark space, cathode glow
0.05	column splits into striations
0.01	cathode rays; the glass glows
10^{-4}	no discharge

Gas	Air	H_2	N_2	Cl_2	CO_2	Neon
Colour	purple red	blue	red	green	bluish white	dark red

25.1.2 Properties of cathode rays

- Streams of fast electrons, produced at about 10^{-2} mm of Hg.
- They travel in straight lines and leave the cathode normally.
- They exert force, produce heat and cause fluorescence.
- They are deflected by electric **and** magnetic fields.
- They ionise gases and pass through thin metal foils.
- Speed: from $\frac{1}{30}$ to $\frac{1}{10}$ of the speed of light.
- On a heavy metal target they produce X-rays.

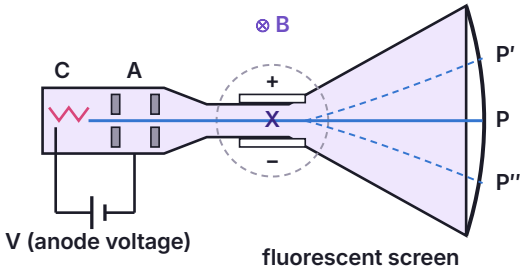
25.1.3 Ways of getting electrons out

- **Thermionic**: by heating; thermions are electrons.
- **Photoelectric**: by light. **Secondary**: by fast electrons hitting a surface.
- An oxide coating lowers the work function, so a coated filament emits at a lower temperature.
- X-ray emission gives out photons, not electrons.

25.1.4 Thomson's experiment

- Crossed E and B act on the beam.
- Fields are adjusted so that the beam reaches P with no deflection.

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Crossed fields act on the electron beam

$$eE = evB \Rightarrow v = \frac{E}{B}$$

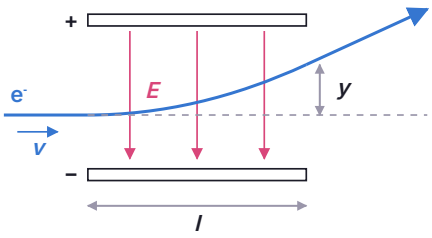
- Anode voltage gives the speed.

$$eV = \tfrac{1}{2}mv^2 \Rightarrow v = \sqrt{\left(\frac{2eV}{m}\right)}$$

$$\frac{e}{m} = \frac{v^2}{2V} = \frac{E^2}{2VB^2}$$

- $\frac{e}{m} = 1.77 \times 10^{11}\ \frac{C}{kg}$, far above that of the proton.
- It does not depend on the gas in the tube.
- At large speed the mass grows, $m = m_0 \div \sqrt{(1 - \frac{v^2}{c^2})}$, so $\frac{e}{m}$ falls.
- Switch off E, keep B: the beam moves in a **circle**.

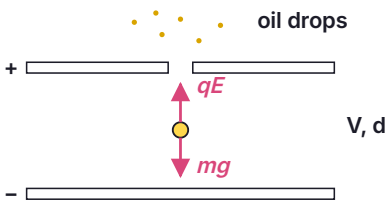
25.1.5 Deflection in an electric field



The path is a parabola inside the plates

$$y = \tfrac{1}{2}\left(\frac{eE}{m}\right)\frac{l^2}{v^2}$$

25.1.6 Millikan's oil drop experiment



A balanced drop stays at rest

$$\text{balanced drop: } qE = mg,\ E = \frac{V}{d}$$

- Charge on a drop is always a whole number times e.

$$q = ne,\ e = 1.6 \times 10^{-19}\ C$$

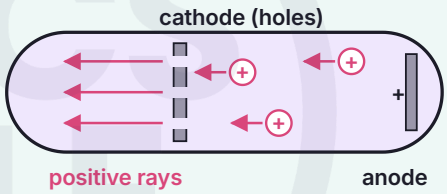
JEE · NEET Corner

Millikan: charge on the drop

$$q = \frac{6\pi\eta(v_1 + v_2)d}{V}\left[\frac{9\eta v_1}{2g(\rho - \sigma)}\right]^{1/2}$$

- η = viscosity of air, d = gap between the plates, V = voltage.
- v_1 = terminal speed with no field; v_2 = terminal speed with the field on.
- ρ = density of oil, σ = density of air.

Positive rays



Positive ions pass through the holes in the cathode

- Made at about 10^{-3} mm of Hg when fast electrons ionise gas atoms.
- They carry a **range of speeds**, much smaller than cathode rays.
- $\frac{q}{m}$ depends on the gas in the tube; it is largest for hydrogen.
- Deflection in E and B is small compared with cathode rays.
- Their charge is an integral multiple of e.
- They cause more ionisation than cathode rays.
- Their discovery helped in discovering isotopes.

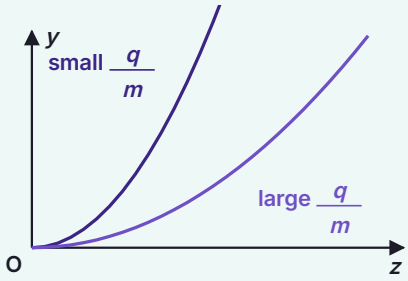
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Thomson's mass spectrograph

- E and B are parallel to each other, and both perpendicular to v.
- Electric deflection is along y; magnetic deflection is along z.

$$y = \frac{qELD}{mv^2} \cdot z = \frac{qBLD}{mv}$$

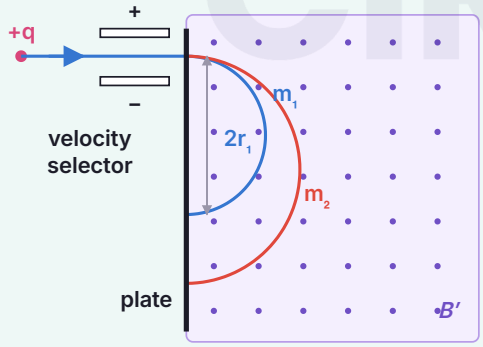
$$z^2 = k\left(\frac{q}{m}\right)y,\ k = \frac{B^2LD}{E}$$



One parabola for each value of $\frac{q}{m}$

- Ions of the same $\frac{q}{m}$ lie on one parabola; faster ions lie nearer the origin.
- The number of parabolas gives the number of isotopes.

Bainbridge mass spectrograph



Velocity selector followed by the analysing field

- Velocity selector (E ⊥ B) lets through only $v = \frac{E}{B}$.
- In the analysing field B′ the ions move on circles.

$$r = \frac{mE}{qBB'} \cdot \frac{r_1}{r_2} = \frac{m_1}{m_2}$$

$$\text{separation of traces} = \frac{2v(m_2 - m_1)}{qB'}$$

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Solved Examples 01 Discharge, Cathode Rays & Thomson

SOLVED 1 AIPMT 2008

In the phenomenon of electric discharge through gases at low pressure, the coloured glow in the tube appears as a result of

(a) collisions between the charged particles emitted from the cathode and the atoms of the gas
(b) collision between different electrons of the atoms of the gas
(c) excitation of electrons in the atoms
(d) collision between the atoms of the gas

STEP 1 Charged particles leave the cathode and speed up in the field
STEP 2 They hit gas atoms and excite them
STEP 3 The atoms then give out light: **collisions of charged particles with gas atoms**

Answer: **(a)**

SOLVED 2 AIPMT 2006

In a discharge tube ionization of enclosed gas is produced due to collisions between

(a) neutral gas atoms/molecules
(b) positive ions and neutral atoms/molecules
(c) negative electrons and neutral atoms/molecules
(d) photons and neutral atoms/molecules

STEP 1 Electrons are light, so the field gives them large speed
STEP 2 A fast electron knocks an electron out of a neutral atom
STEP 3 Ionization is by **electrons hitting neutral atoms/molecules**

Answer: **(c)**

SOLVED 3 AIPMT 1996

In a discharge tube at 0.02 mm, there is formation of

(a) Crooke's dark space
(b) Faraday's dark space
(c) both space partly
(d) none of these

STEP 1 Faraday's dark space appears at about 1.65 mm of Hg
STEP 2 Crooke's dark space grows as the pressure falls further
STEP 3 At 0.02 mm the tube shows **Crooke's dark space**

Answer: **(a)**

SOLVED 4 AIPMT 2010 · Prelims

A beam of cathode rays is subjected to crossed electric (E) and magnetic fields (B). The fields are adjusted such that the beam is not deflected. The specific charge of the cathode rays is given by (V is the potential difference between cathode and anode)

(a) $\frac{B^2}{2VE^2}$ (b) $\frac{2VB^2}{E^2}$
(c) $\frac{2VE^2}{B^2}$ (d) $\frac{E^2}{2VB^2}$

STEP 1 No deflection: $eE = evB \Rightarrow v = \frac{E}{B}$
STEP 2 $eV = \frac{1}{2}mv^2 \Rightarrow \frac{e}{m} = \frac{v^2}{2V}$
STEP 3 $\frac{e}{m} = \frac{E^2}{2VB^2}$

Answer: **(d)**

SOLVED 5 AIPMT 2007

A beam of electron passes undeflected through mutually perpendicular electric and magnetic fields. If the electric field is switched off, and the same magnetic field is maintained, the electrons move

(a) in a circular orbit
(b) along a parabolic path
(c) along a straight line
(d) in an elliptical orbit

STEP 1 Only the magnetic force evB is left
STEP 2 It is always perpendicular to the velocity
STEP 3 It acts as a centripetal force: **circular orbit**

Answer: **(a)**

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Solved Examples 01 Discharge, Cathode Rays & Thomson (contd.)

SOLVED 6 AIPMT 2003

J.J. Thomson's cathode-ray tube experiment demonstrated that

(a) cathode rays are streams of negatively charged ions

(b) all the mass of an atom is essentially in the nucleus

(c) the $\frac{e}{m}$ of electrons is much greater than the $\frac{e}{m}$ of protons

(d) the $\frac{e}{m}$ ratio of the cathode-ray particles changes when a different gas is placed in the discharge tube

STEP 1 Thomson measured $\frac{e}{m} = 1.77 \times 10^{11}\ \frac{C}{kg}$

STEP 2 This value does not depend on the gas

STEP 3 It is far above the value for hydrogen ions, so **$\frac{e}{m}$ of electrons is much greater**

Answer: **(c)**

SOLVED 7 AIPMT 2002

Which of the following is not the property of cathode rays?

(a) It produces heating effect

(b) It does not deflect in electric field

(c) It casts shadow

(d) It produces fluorescence

STEP 1 Cathode rays are moving electrons, so they carry charge

STEP 2 A charged beam bends in an electric field

STEP 3 The false statement is **"does not deflect in electric field"**

Answer: **(b)**

SOLVED 8 AIPMT 2001

In Thomson mass spectrograph **E** $\perp$ **B**, then the velocity of electron beam will be

(a) $\frac{|E|}{|B|}$ (b) $E \times B$

(c) $\frac{|B|}{|E|}$ (d) $\frac{E^2}{B^2}$

STEP 1 Undeflected beam: electric force = magnetic force

STEP 2 $eE = evB$

STEP 3 $v = \frac{|E|}{|B|}$

Answer: **(a)**

SOLVED 9 AIPMT 1997

The kinetic energy of an electron, which is accelerated in the potential difference of 100 volts, is

(a) 416.6 cal

(b) 6.636 cal

(c) 1.602×10^{-17} J

(d) 1.6×10^{4} J

STEP 1 $K = eV$

STEP 2 $K = 1.602 \times 10^{-19} \times 100$

STEP 3 $K = \mathbf{1.602 \times 10^{-17}\ J}$

Answer: **(c)**

SOLVED 10 AIPMT 1996

An electron of mass m and charge e is accelerated from rest through a potential difference V in vacuum. Its final velocity will be

(a) $\sqrt{\frac{2eV}{m}}$ (b) $\sqrt{\frac{eV}{m}}$

(c) $\frac{eV}{2m}$ (d) $\frac{eV}{m}$

STEP 1 Loss in potential energy = gain in kinetic energy

STEP 2 $eV = \frac{1}{2}mv^2$

STEP 3 $v = \sqrt{\frac{2eV}{m}}$

Answer: **(a)**

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DUAL NATURE OF

RADIATION AND MATTER

LEVEL 1 · EASY

Topic-wise Previous Year Questions

MHT CET · NEET · JEE Main

248	24	7
questions	concepts	topics

CONTENTS

01	Cathode Rays, Thomson's Experiment & Gas Discharge	Q 1–10	10 Qs
02	Photons: Energy, Momentum & Radiation Pressure	Q 11–47	37 Qs
03	Photoelectric Effect: Einstein's Equation	Q 48–120	73 Qs
04	Photoelectric Experiment: Intensity, Stopping Potential & Graphs	Q 121–177	57 Qs
05	Matter Waves: de Broglie Wavelength	Q 178–236	59 Qs
06	Davisson-Germer, Uncertainty, Compton & X-Rays	Q 237–246	10 Qs
07	Other / Mixed: Atoms & Bohr Links	Q 247–248	2 Qs
	Answer key		

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TOPIC 01

Cathode Rays, Thomson's Experiment & Gas Discharge

10 PYQs · Easy 10 · Medium 0 · Difficult 0 | MHT CET 0 · NEET 10 · JEE 0

Concepts covered: Electric discharge through gases (3) · Cathode rays & Thomson's e/m (3) · Electron emission & accelerated electrons (4)

LEVEL 1 · EASY 10 questions

◆ Electric discharge through gases 3 Qs

1. In the phenomenon of electric discharge through gases at low pressure, the coloured glow in the tube appears as a result of
AIPMT 2008
(a) collisions between the charged particles emitted from the cathode and the atoms of the gas
(b) collision between different electrons of the atoms of the gas
(c) excitation of electrons in the atoms
(d) collision between the atoms of the gas

2. In a discharge tube ionization of enclosed gas is produced due to collisions between
AIPMT 2006
(a) neutral gas atoms/molecules
(b) positive ions and neutral atoms/molecules
(c) negative electrons and neutral atoms/molecules
(d) photons and neutral atoms/molecules.

3. In a discharge tube at 0.02 mm, there is formation of
AIPMT 1996 *(Not in current JEE/NEET syllabus)*
(a) Crooke's dark space (b) Faraday's dark space
(c) both space partly (d) none of these

◆ Cathode rays & Thomson's e/m 3 Qs

4. A beam of cathode rays is subjected to crossed electric (E) and magnetic fields (B). The fields are adjusted such that the beam is not deflected. The specific charge of the cathode rays is given by (Where V is the potential difference between cathode and anode)
AIPMT 2010 · PRELIMS
(a) $\frac{B^2}{2VE^2}$ (b) $\frac{2VB^2}{E^2}$ (c) $\frac{2VE^2}{B^2}$ (d) $\frac{E^2}{2VB^2}$

5. J.J. Thomson's cathode-ray tube experiment demonstrated that
AIPMT 2003
(a) cathode rays are streams of negatively charged ions
(b) all the mass of an atom is essentially in the nucleus
(c) the e/m of electrons is much greater than the e/m of protons
(d) the e/m ratio of the cathode-ray particles changes when a different gas is placed in the discharge tube

6. Which of the following is not the property of cathode rays?
AIPMT 2002
(a) In produces heating effect
(b) It does not deflect in electric field
(c) It casts shadow
(d) It produces fluorscence.

◆ Electron emission & accelerated electrons 4 Qs

7. The kinetic energy of an electron, which is accelerated in the potential difference of 100 volts, is
AIPMT 1997
(a) 416.6 cal (b) 6.636 cal
(c) 1.602×10^{-17} J (d) 1.6×10^{4} J.

8. An electron of mass m and charge e is accelerated from rest through a potential difference V in vacuum. Its final velocity will be
AIPMT 1996
(a) $\sqrt{\frac{2eV}{m}}$ (b) $\sqrt{\frac{eV}{m}}$ (c) $\frac{eV}{2m}$ (d) $\frac{eV}{m}$

9. In which of the following, emission of electrons does not take place
AIPMT 1990
(a) thermionic emission
(b) X-rays emission
(c) photoelectric emission
(d) secondary emission

10. Thermions are
AIPMT 1988
(a) protons (b) electrons
(c) photons (d) positrons

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TOPIC 02

Photons: Energy, Momentum & Radiation Pressure

37 PYQs · Easy 37 · Medium 0 · Difficult 0 | MHT CET 5 · NEET 18 · JEE 14

Concepts covered: Photon energy, wavelength & momentum (15) · Number of photons from a source (15) · Radiation pressure & force of light (2) · Particle vs wave nature of light (5)

LEVEL 1 · EASY 37 questions

◆ Photon energy, wavelength & momentum 15 Qs

11. A photon has wavelength 3 nm, then its momentum and energy respectively will be [h = 6.63×10^{-34} Js, c = velocity of light = 3×10^8 m/s]

MHT CET 2021 · 24 SEP · SHIFT 1

(a) 2.21×10^{-43} kg ms^{-1} ; 6.63×10^{-34} J
(b) 2.21×10^{-34} kg ms^{-1} ; 6.63×10^{-25} J
(c) 2.21×10^{-25} kg ms^{-1} ; 6.63×10^{-17} J
(d) 2.21×10^{-16} kg ms^{-1} ; 6.63×10^{-19} J

12. When a photon enters glass from air, which one of the following quantity does not change?

MHT CET 2021 · 22 SEP · SHIFT 2

(a) Energy (b) Velocity
(c) Wavelength (d) Momentum

13. If c is the velocity of light in free space, the correct statements about photon among the following are:
A. The energy of a photon is $E = h\nu$.
B. The velocity of a photon is c.
C. The momentum of a photon, $p = \frac{h\nu}{c}$.
D. In a photon-electron collision, both total energy and total momentum are conserved. E. Photon possesses positive charge.
Choose the correct answer from the options given below:

NEET 2024

(a) A and B only (b) A, B, C and D only
(c) A, C and D only (d) A, B, D and E only

14. The momentum of a photon of energy 1 MeV in kg m/s will be

AIPMT 2006

(a) 5×10^{-22} (b) 0.33×10^6
(c) 7×10^{-24} (d) 10^{-22}

15. The value of Planck's constant is

AIPMT 2002

(a) 6.63×10^{-34} J/sec.
(b) 6.63×10^{-34} kg-m^2/sec
(c) 6.63×10^{-34} kg-m^2
(d) 6.63×10^{-34} J-sec.

16. By photoelectric effect, Einstein proved

AIPMT 2000

(a) E = hυ (b) K.E. = $\frac{1}{2}$ mv2
(c) E = mc2 (d) E = $\frac{-Rhc^2}{n^2}$

17. The energy of a photon of light is 3 eV. Then the wavelength of photon must be

AIPMT 2000

(a) 4125 nm (b) 412.5 nm
(c) 41250 nm (d) 4 nm

18. If a photon has velocity c and frequency ν, then which of the following represents its wavelength?

AIPMT 1996

(a) $\frac{h\nu}{c^2}$ (b) $h\nu$ (c) $\frac{hc}{E}$ (d) $\frac{h\nu}{c}$

19. The velocity of photons is proportional to (where ν = frequency)

AIPMT 1996

(a) $1/\sqrt{\nu}$ (b) ν^2 (c) ν (d) $\sqrt{\nu}$

20. Momentum of photon wavelength λ is

AIPMT 1993

(a) $\frac{h\nu}{c}$ (b) zero (c) $\frac{h\lambda}{c^2}$ (d) $\frac{h\lambda}{c}$

21. The wavelength of a 1 keV photon is 1.24×10^{-9} m. What is the frequency of 1 MeV photon?

AIPMT 1991

(a) 1.24×10^{15} (b) 2.4×10^{20}
(c) 1.24×10^{18} (d) 2.4×10^{23}

22. The momentum of a photon of an electromagnetic radiation is 3.3×10^{-29} kg ms $^{-1}$. What is the frequency of the associated waves?
[$h = 6.6 \times 10^{-34}$ Js; $c = 3 \times 10^8$ ms^{-1}]

AIPMT 1990

(a) 1.5×10^{13} Hz (b) 7.5×10^{12} Hz
(c) 6×10^3 Hz (d) 3×10^3 Hz

23. The energy of a photon of wavelength λ is

AIPMT 1988

(a) $hc\lambda$ (b) $\frac{hc}{\lambda}$ (c) $\frac{\lambda}{hc}$ (d) $\frac{\lambda h}{c}$

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24. Given below are two statements:

Statement I: Two photons having equal linear momenta have equal wavelengths. Statement II: If the wavelength of photon is decreased, then the momentum and energy of a photon will also decrease.

In the light of the above statements, choose the correct answer from the options given below.

JEE MAIN 2021 · 24 FEB · SHIFT 1

(a) Statement I is false but Statement II is true
(b) Both Statement I and Statement II are false
(c) Both Statement I and Statement II are true
(d) Statement I is true but Statement II is false

25. Photon of frequency v has a momentum associated with it. If c is the velocity of light, the momentum is

AIEEE 2007

(a) hv/c (b) v/c (c) $h\,v\,c$ (d) hv/c^2

◆ Number of photons from a source 15 Qs

26. The number of photons per second emitted by the source of monochromatic light of wavelength 600 nm, when it delivers the power of 3.3×10^{-3} W will be (Planck's constant $= 6.6 \times 10^{-34}$ Js, $c = 3 \times 10^8$ m/s)

MHT CET 2026 · 15 MAY · SHIFT 2

(a) 10^{17} (b) 10^{16} (c) 10^{15} (d) 10^{18}

27. When light of wavelength 'λ' is incident on a photosensitive surface, photons of power 'P' are emitted. The number of photon 'n' emitted in time 't' is [h = Planck's constant, c = velocity of light in vacuum]

MHT CET 2021 · 20 SEP · SHIFT 1

(a) $\frac{hc}{P\lambda t}$ (b) $\frac{P\lambda}{htc}$ (c) $\frac{P\lambda t}{hc}$ (d) $\frac{hP}{\lambda tc}$

28. The number of photons per second on an average emitted by the source of monochromatic light of wavelength 600nm, when it delivers the power of 3.3 $\times 10^{-3}$ watt will be: (h = 6.6 $\times 10^{-34}$ Js)

NEET 2021

(a) 10^{15} (b) 10^{18} (c) 10^{17} (d) 10^{16}

29. A source S_1 is producing, 10^{15} photons per second of wavelength 5000 $\mathring{A}$. Another source S_2 is producing 1.02×10^{15} photons per second of wavelength 5100 $\mathring{A}$. Then, (power of S_2)/(power of S_1) is equal to

AIPMT 2010 · PRELIMS

(a) 1.00 (b) 1.02 (c) 1.04 (d) 0.98

30. Monochromatic light of wavelength 667 nm is produced by a helium neon laser. The power emitted is 9 mW. The number of photons arriving per sec. on the average at a target irradiated by this beam is

AIPMT 2009

(a) 3×10^{16} (b) 9×10^{15} (c) 3×10^{19} (d) 9×10^{17}

31. Monochromatic light of frequency 6.0×10^{14} Hz is produced by a laser. The power emitted is 2×10^{-3} W. The number of photons emitted, on the average, by the source per second is

AIPMT 2007

(a) 5×10^{16} (b) 5×10^{17} (c) 5×10^{14} (d) 5×10^{15}

32. A radio transmitter operates at a frequency 880 kHz and a power of 10 kW. The number of photons emitted per second is

AIPMT 1990

(a) 1.72×10^{31} (b) 1.327×10^{25}
(c) 1.327×10^{37} (d) 1.327×10^{45}

33. Number of photons of equal energy emitted per second by a 6 mW laser source operating at 663 nm is _____.

(Given: $h = 6.63 \times 10^{-34}$ J.s and $c = 3 \times 10^8$ m/s)

JEE MAIN 2026 · 28 JAN · SHIFT 2

(a) 10×10^{15} (b) 5×10^{16}
(c) 5×10^{15} (d) 2×10^{16}

34. Given below are two statements: one is labelled as Assertion **A** and the other is labelled as Reason R.

Assertion A: Number of photons increases with increase in frequency of light.

Reason R: Maximum kinetic energy of emitted electrons increases with the frequency of incident radiation.

In the light of the above statements, choose the most appropriate answer from the options given below:

JEE MAIN 2024 · 4 APR · SHIFT 2

(a) **A** is not correct but **R** is correct.
(b) **A** is correct but **R** is not correct.
(c) Both **A** and **R** are correct and **R** is the correct explanation of **A**.
(d) Both **A** and **R** are correct and **R** is NOT the correct explanation of **A**.

35. Monochromatic light of frequency 6×10^{14} Hz is produced by a laser. The power emitted is 2×10^{-3} W .

How many photons per second on an average, are emitted by the source?

(Given h $= 6.63 \times 10^{-34}$Js)

JEE MAIN 2024 · 1 FEB · SHIFT 2

(a) 5×10^{15} (b) 7×10^{16} (c) 6×10^{15} (d) 9×10^{18}

36. Two sources of light emit with a power of 200 W. The ratio of number of photons of visible light emitted by each source having wavelengths 300 nm and 500 nm respectively, will be:

JEE MAIN 2024 · 29 JAN · SHIFT 2

(a) 5 : 3 (b) 3 : 5 (c) 1 : 5 (d) 1 : 3

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37. A source of monochromatic light liberates 9×10^{20} photon per second with wavelength 600 nm when operated at 400 W. The number of photons emitted per second with wavelength of 800 nm by the source of monochromatic light operating at same power will be:

JEE MAIN 2022 · 30 JUN · SHIFT 1

(a) 12×10^{20} (b) 6×10^{20}
(c) 9×10^{20} (d) 24×10^{20}

38. Two sources of light emit X-rays of wavelength 1 nm and visible light of wavelength 500 nm, respectively. Both the sources emit light of the same power 200 W. The ratio of the number density of photons of X-rays to the number density of photons of the visible light of the given wavelengths is:

JEE MAIN 2020 · 3 SEP · SHIFT 2

(a) $\frac{1}{500}$ (b) 500 (c) 250 (d) $\frac{1}{250}$

39. A 2 mW laser operates at wavelength of 500 nm. The number of photons that will be emitted per second is: [Given Planck's constant h = 6.6×10^{-34} Js, speed of light c = 3.0×10^8 m/s]

JEE MAIN 2019 · 10 APR · SHIFT 2

(a) 5×10^{15} (b) 1.5×10^{16}
(c) 1×10^{16} (d) 2×10^{16}

40. A Laser light of wavelength 660 nm is used to weld Retina detachment. If a Laser pulse of width 60 ms and power 0.5 kW is used the approximate number of photons in the pulse are: [Take Planck's constant h = 6.62×10^{-34} Js]

JEE MAIN 2017 · 9 APR · SHIFT 1

(a) 10^{20} (b) 10^{18} (c) 10^{22} (d) 10^{19}

◆ Radiation pressure & force of light 2 Qs

41. If the total energy transferred to a surface in time t is 6.48×10^5 J , then the magnitude of the total momentum delivered to this surface for complete absorption will be:

JEE MAIN 2024 · 30 JAN · SHIFT 2

(a) 2.16×10^{-3} kg m/s (b) 2.46×10^{-3} kg m/s
(c) 1.58×10^{-3} kg m/s (d) 4.32×10^{-3} kg m/s

42. A small object at rest, absorbs a light pulse of power 20 mW and duration 300 ns. Assuming speed of light as 3×10^8 m/s, the momentum of the object becomes equal to:

JEE MAIN 2023 · 30 JAN · SHIFT 1

(a) 1×10^{-17} kg m/s (b) 0.5×10^{-17} kg m/s
(c) 3×10^{-17} kg m/s (d) 2×10^{-17} kg m/s

◆ Particle vs wave nature of light 5 Qs

43. Dual nature of light is exhibited by

MHT CET 2023 · 13 MAY · SHIFT 2

(a) diffraction as well as photoelectric effect
(b) diffraction as well as reflection
(c) refraction as well as interference
(d) photoelectric effect

44. Match List I with List II.

NEET 2026

List-I	List-II
A. $E = hv$	I. de Broglie wavelength
B. Diffraction and Interference	II. Particle nature of light
C. $\lambda = h/p$	III. Wave nature of light
D. Compton effect	IV. Energy of photon

(a) A-IV, B-I, C-II, D-III
(b) A-IV, B-III, C-II, D-I
(c) A-I, B-IV, C-III, D-II
(d) A-IV, B-III, C-I, D-II

45. Which one among the following shows particle nature of light?

AIPMT 2001

(a) photo electric effect (b) interference
(c) refraction (d) polarization.

46. Which of the following phenomena cannot be explained by wave theory of light?

JEE MAIN 2025 · 28 JAN · SHIFT 2

(a) Refraction of light (b) Reflection of light
(c) Diffraction of light (d) Compton effect

47. Which of the following phenomena is not explained by wave nature of light?

A. reflection
B. diffraction
C. photoelectric effect
D. interference
E. polarization

Choose the most appropriate answer from the options given below:

JEE MAIN 2024 · 6 APR · SHIFT 1

(a) C only (b) B, D only (c) A, C only (d) E only

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TOPIC 03

Photoelectric Effect: Einstein's Equation

73 PYQs · Easy 73 · Medium 0 · Difficult 0 | MHT CET 27 · NEET 21 · JEE 25

Concepts covered: Work function, threshold frequency & wavelength (24) · Einstein's equation: direct numericals (25) · Maximum speed of photoelectrons (18) · Changing frequency or wavelength: KE ratios (6)

LEVEL 1 · EASY 73 questions

◆ Work function, threshold frequency & wavelength 24 Qs

48. Sodium and copper have work functions 2.3 eV and 4.5 eV respectively. The ratio of threshold wavelength of sodium to that of copper is nearest to

MHT CET 2025 · 25 APR · SHIFT 1

(a) 1 : 4 (b) 4 : 1 (c) 1 : 2 (d) 2 : 1

49. Light of wavelength ' λ ' falls on a metal having work function $\frac{hc}{\lambda_0}$. Photoelectric effect will take place only if (λ_0 is the threshold wavelength)

MHT CET 2025 · 20 APR · SHIFT 1

(a) $\lambda \geq \lambda_0$ (b) $\lambda \geq 2\lambda_0$ (c) $\lambda \leq \lambda_0$ (d) $\lambda = 4\lambda_0$

50. When a light of wavelength 300 nm falls on a photoelectric emitter, photo electrons are emitted. For another emitter light of wavelength 600 nm is just sufficient for liberating photoelectrons. The ratio of the work function of the two emitters is

MHT CET 2023 · 13 MAY · SHIFT 1

(a) 1: 2 (b) 2: 1 (c) 4: 1 (d) 1: 4

51. A ray of light with wavelength λ is incident on three different photoelectric cells namely 1,2 and 3. The threshold wavelength of these photoelectric cells are λ_1, λ_2, and λ_3, respectively and the magnitude of stopping potentials of these cells are V_1, V_2 and V_3, respectively. The relation between λ and threshold wavelengths are $\lambda_1 < \lambda, \lambda_2 > \lambda$ and $\lambda_3 \gg \lambda$. The correct option is:

RE-NEET 2026

(a) $V_1 < V_2, V_3 = 0$ (b) $V_1 = 0, V_2 < V_3$
(c) $V_1 = 0, V_2 > V_3$ (d) $V_1 > V_2, V_3 = 0$

52. For a metal of work function 6.6 eV, which of the following wavelengths of incident radiation does not give rise to the photoelectric effect?
(Take Planck's constant as 6.6×10^{-34} J s)

NEET 2026

(a) 100 nm (b) 150 nm (c) 200 nm (d) 50 nm

53. The work functions of Caesium (Cs), potassium (K) and Sodium (Na) are 2.14 eV, 2.30 eV and 2.75 eV respectively. If incident electromagnetic radiation has an incident energy of 2.20 eV, which of these photosensitive surfaces may emit photoelectrons?

NEET 2023

(a) Both Na and K (b) K only
(c) Na only (d) Cs only

54. The work function of a photosensitive material is 4.0 eV. The longest wavelength of light that can cause photon emission from the substance is (approximately)

NEET 2019

(a) 310 nm (b) 3100 nm (c) 966 nm (d) 31 nm

55. Photoelectric emission occurs only when the incident light has more than a certain minimum

AIPMT 2011 · PRELIMS

(a) power (b) wavelength
(c) intensity (d) frequency

56. The work functions for metals A, B and C are respectively 1.92 eV, 2.0 eV and 5 eV. According to Einstein's equation the metals which will emit photoelectrons for a radiation of wavelength 4100 $\mathring{A}$ is/are

AIPMT 2005

(a) A only (b) A and B only
(c) all the three metals (d) none

57. When ultraviolet rays incident on metal plate then photoelectric effect does not occur, it occurs by incidence of

AIPMT 2002

(a) infrared rays (b) X-rays
(c) radio wave (d) micro wave

58. The photoelectric work function for a metal surface is 4.125 eV. The cut-off wavelength for this surface is

AIPMT 1999

(a) 4125 Å (b) 3000 Å (c) 6000 Å (d) 2062.5 Å

59. When light of wavelength 300 nm (nanometer) falls on a photoelectric emitter, photoelectrons are liberated. For another emitter, however, light of 600 nm wavelength is sufficient for creating photoemission. What is the ratio of the work functions of the two emitters?

AIPMT 1993

(a) 1 : 2 (b) 2 : 1 (c) 4 : 1 (d) 1 : 4

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60. The threshold frequency for photoelectric effect on sodium corresponds to a wavelength of 5000 Å. Its work function is

AIPMT 1988

(a) 4×10^{-19} J (b) 1 J
(c) 2×10^{-19} J (d) 3×10^{-19} J

61. Light is incident on a metallic plate having work function 110×10^{-20} J. If the produced photoelectrons have zero kinetic energy then the angular frequency of the incident light is ____ rad/s. $\left(h = 6.63 \times 10^{-34}\ J.s\right)$.

JEE MAIN 2026 · 22 JAN · SHIFT 2

(a) 1.04×10^{13} (b) 1.66×10^{16}
(c) 1.66×10^{15} (d) 1.04×10^{16}

62. The work function of a metal is 3 eV. The color of the visible light that is required to cause emission of photoelectrons is

JEE MAIN 2025 · 3 APR · SHIFT 1

(a) Red (b) Green (c) Blue (d) Yellow

63. The work functions of cesium (Cs) and lithium (Li) metals are 1.9 eV and 2.5 eV, respectively. If we incident a light of wavelength 550 nm on these two metal surfaces, then photo-electric effect is possible for the case of

JEE MAIN 2025 · 22 JAN · SHIFT 1

(a) Both Cs and Li (b) Neither Cs nor Li
(c) Li only (d) Cs only

64. The work function of a substance is 3.0 eV. The longest wavelength of light that can cause the emission of photoelectrons from this substance is approximately;

JEE MAIN 2024 · 30 JAN · SHIFT 1

(a) 215 nm (b) 400 nm (c) 414 nm (d) 200 nm

65. The threshold frequency of a metal with work function 6.63 eV is:

JEE MAIN 2024 · 27 JAN · SHIFT 2

(a) 16×10^{15} Hz (b) 16×10^{12} Hz
(c) 1.6×10^{15} Hz (d) 1.6×10^{12} Hz

66. The difference between threshold wavelengths for two metal surfaces A and B having work function $\phi_A = 9$ eV and $\phi_B = 4.5$ eV in nm is:
{ Given, hc = 1242 eVnm}

JEE MAIN 2023 · 13 APR · SHIFT 1

(a) 264 (b) 138 (c) 540 (d) 276

67. If the two metals A and B are exposed to radiation of wavelength 350 nm. The work functions of metals A and B are 4.8eV and 2.2eV. Then choose the correct option.

JEE MAIN 2023 · 31 JAN · SHIFT 2

(a) Metal B will not emit photo-electrons
(b) Both metals A and B will not emit photo-electrons
(c) Metal A will not emit photo-electrons
(d) Both metals A and B will emit photo-electrons

68. The threshold wavelength for photoelectric emission from a material is 5500 $\overset{o}{A}$. Photoelectrons will be emitted, when this material is illuminated with monochromatic radiation from a A. 75 W infra-red lamp
B. 10 W infra-red lamp
C. 75 W ultra-violet lamp
D. 10 W ultra-violet lamp
Choose the correct answer from the options given below:

JEE MAIN 2023 · 29 JAN · SHIFT 1

(a) C only (b) A and D only
(c) C and D only (d) B and C only

69. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R:
Assertion A: The photoelectric effect does not takes place, if the energy of the incident radiation is less than the work function of a metal.
Reason R: Kinetic energy of the photoelectrons is zero, if the energy of the incident radiation is equal to the work function of a metal.
In the light of the above statements, choose the most appropriate answer from the options given below.

JEE MAIN 2022 · 29 JUN · SHIFT 1

(a) Both A and R are correct and R is the correct explanation of A.
(b) Both A and R are correct but R is not the correct explanation of A.
(c) A is correct but R is not correct.
(d) A is not correct but R is correct.

70. The work function of a substance is 4.0 eV. The longest wavelength of light that can cause photo-electron emission from this substance is approximately.

AIEEE 2004

(a) 310 nm (b) 400 nm (c) 540 nm (d) 220 nm

71. Sodium and copper have work functions 2.3 eV and 4.5 eV respectively. Then the ratio of the wavelengths is nearest to

AIEEE 2002

(a) 1 : 2 (b) 4 : 1 (c) 2 : 1 (d) 1 : 4

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◆ Einstein's equation: direct numericals 25 Qs

72. For a photosensitive material, work function is 'W_0' and stopping potential is 'V'. The wavelength of the incident radiation is (h=Planck's constant, c = velocity of light, e = electronic charge)

MHT CET 2026 · 16 APR · SHIFT 1

(a) $\frac{hc}{(W_0 - eV)}$ (b) $\frac{hc}{(W_0 + eV)}$
(c) $^{hc}(W_0 -^{eV})$ (d) $^{hc}(W_0 +^{eV})$

73. The maximum velocity of the photoelectrons emitted by a metal surface is 9×10^5 m/s. The value of ratio of charge (e) to mass (m) of the photoelectron is 1.8×10^{11}C/kg. The value of stopping potential in volt is

MHT CET 2025 · 19 APR · SHIFT 2

(a) 2.00 (b) 2.25 (c) 2.50 (d) 3.00

74. For a photosensitive material, work function is ' W_0 ' and stopping potential is ' V '. The wavelength of incident radiation is (h = Planck's constant, c = velocity of light, e = electronic charge)

MHT CET 2024 · 4 MAY · SHIFT 1

(a) $\frac{h^2c^2}{W_0+eV}$ (b) $\frac{hc}{W_0}$ (c) $\frac{hcV}{W_0}$ (d) $\frac{hc}{W_0+eV}$

75. The stopping potential for a photelectric emission process is 10 V. The maximum kinetic energy of the electrons ejected in the process is [Charge on electron e = 1.6×10^{-19}C]

MHT CET 2024 · 2 MAY · SHIFT 2

(a) 3.2×10^{-19} J (b) 1.6×10^{-19} J
(c) 1.6×10^{-18} J (d) 0 J

76. A metal surface of work function 1.13 eV is irradiated with light of wavelength 310 nm . The retarding potential required to stop the escape of photoelectrons is [Take $\frac{hc}{e} = 1240 \times 10^{-9}$SI units]

MHT CET 2023 · 11 MAY · SHIFT 2

(a) 1.13 V (b) 2.87 V (c) 3.97 V (d) 4.23 V

77. The light of wavelength 'λ' is incident on the surface of metal of work function ϕ and emits the electron. The maximum velocity of electron emitted is [m = mass of electron and h = Planck's constant, c = velocity of light]

MHT CET 2021 · 22 SEP · SHIFT 2

(a) $\left[\frac{2(hc-\lambda)}{m\lambda}\right]^{\frac{1}{2}}$ (b) $\left[\frac{2(hc-\phi)\lambda}{mc}\right]$
(c) $\left[\frac{2(hc-\lambda)}{m\lambda}\right]$ (d) $\left[\frac{2(hc-\lambda\phi)}{m\lambda}\right]^{\frac{1}{2}}$

78. If the maximum kinetic energy of emitted electrons in photoelectric effect is 3.2×10^{-19} J and the work-function for metal is 6.63×10^{-19} J, then stopping potential and threshold wavelength respectively are
[Planck's constant, $h = 6.63 \times 10^{-34}$ J-s]
[Velocity of light, $c = 3 \times 10^8 \frac{m}{s}$]
[Charge on electron $= 1.6 \times 10^{-19}$C]

MHT CET 2020 · 19 OCT · SHIFT 2

(a) 4V, 6000$\overset{o}{A}$ (b) 3V, 4000$\overset{o}{A}$
(c) 2V, 3000$\overset{o}{A}$ (d) 1V, 1000$\overset{o}{A}$

79. The light of wavelength λ incident on the surface of metal having work function ϕ emits the electrons. The maximum velocity of electrons emitted is [c = velocity of light, h = Planck's constant, m = mass of electron]

MHT CET 2020 · 16 OCT · SHIFT 2

(a) $\left[\frac{2(h\nu-\phi)\lambda}{mc}\right]$ (b) $\left[\frac{2(hc-\lambda\phi)}{m\lambda}\right]^{1/2}$
(c) $\left[\frac{2(hc-\lambda)}{m\lambda}\right]^{1/2}$ (d) $\left[\frac{2(hc-\phi)}{m\lambda}\right]$

80. The maximum velocity of the photoelectron emitted by the metal surface is v. Charge and mass of the photoelectron is denoted by e and m, respectively. The stopping potential in volt is

MHT CET 2020 · 16 OCT · SHIFT 1

(a) $\frac{v^2}{2\left(\frac{e}{m}\right)}$ (b) $\frac{v^2}{\left(\frac{m}{e}\right)}$ (c) $\frac{v^2}{2\left(\frac{m}{e}\right)}$ (d) $\frac{v^2}{\left(\frac{e}{m}\right)}$

81. The maximum velocity of the photoelectron emitted by the metal surface is ' v '. Charge and mass of the photoelectron is denoted by ' e ' and ' m ' respectively. The stopping potential in volt is

MHT CET 2019 · 2 MAY · SHIFT 1

(a) $\frac{v^2}{2\left(\frac{m}{e}\right)}$ (b) $\frac{v^2}{2\left(\frac{e}{m}\right)}$ (c) $\frac{v^2}{\left(\frac{e}{m}\right)}$ (d) $\frac{v^2}{\left(\frac{m}{e}\right)}$

82. The light rays having photons of energy 4.2 eV are falling on a metal surface having a work function of 2.2 eV. The stopping potential of the surface is

NEET 2022 · PHASE 2

(a) 6.4 V (b) 2 eV (c) 2 V (d) 1.1 V

83. The threshold frequency of a photoelectric metal is ν_0. If light of frequency $4\nu_0$ is incident on this metal, then the maximum kinetic energy of emitted electrons will be:

NEET 2022 · PHASE 2

(a) 4 $h\nu_0$ (b) $h\nu_0$ (c) 2 $h\nu_0$ (d) 3 $h\nu_0$

84. The threshold frequency for a photosensitive metal is 3.3×10^{14} Hz. If light of frequency 8.2×10^{14} Hz is incident on this metal, the cut- off voltage for the photoelectron emission is nearly

AIPMT 2011 · MAINS

(a) 1 V (b) 2 V (c) 3 V (d) 5 V

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85. In photoelectric emission process from a metal of work function 1.8 eV, the kinetic energy of most energetic electrons is 0.5 eV. The corresponding stopping potential is

AIPMT 2011 · PRELIMS

(a) 1.8 V (b) 1.3 V (c) 0.5 V (d) 2.3 V

86. The potential difference that must be applied to stop the fastest photoelectrons emitted by a nickel surface, having work functions 5.01 eV, when ultraviolet light of 200 nm falls on it, must be

AIPMT 2010 · PRELIMS

(a) 2.4 V (b) – 1.2 V (c) – 2.4 V (d) 1.2 V

87. Light of wavelength 5000 Å falls on a sensitive plate with photoelectric work function of 1.9 eV . The kinetic energy of the photoelectron emitted will be

AIPMT 1998

(a) 0.58 eV (b) 2.48 eV (c) 1.24 eV (d) 1.16 eV

88. Ultraviolet radiations of 6.2 eV falls on an aluminium surface. Kinetic energy of fastest electron emitted is (work function = 4.2 eV)

AIPMT 1989

(a) 3.2×10^{-21} J (b) 3.2×10^{-19} J
(c) 7×10^{-25} J (d) 9×10^{-32} J

89. Light source having wavelength 331 nm is used to generate photo-electrons whose stopping potential is 0.2 V. The work function of the used metal in the experiment is $\alpha \times 10^{-19}$ J. The value of α is ____.
$\left(\mathrm{h} = 6.62 \times 10^{-34}\ \mathrm{J\,s}, \mathrm{e} = 1.6 \times 10^{-19}\mathrm{C}\right.$ and $\left.\mathrm{c} = 3 \times 10^{8}\ \mathrm{m/s}\right)$

JEE MAIN 2026 · 5 APR · SHIFT 1

(a) 3.68 (b) 4.68 (c) 5.68 (d) 2.68

90. In photoelectric effect an em-wave is incident on a metal surface and electrons are ejected from the surface. If the work function of the metal is 2.14 eV and stopping potential is 2 V, what is the wavelength of the em-wave? (Given $\mathrm{hc} = 1242\mathrm{eVnm}$ where h is the Planck's constant and c is the speed of light in vacuum.)

JEE MAIN 2025 · 23 JAN · SHIFT 2

(a) 400 nm (b) 600 nm (c) 300 nm (d) 200 nm

91. UV light of 4.13 eV is incident on a photosensitive metal surface having work function 3.13 eV . The maximum kinetic energy of ejected photoelectrons will be:

JEE MAIN 2024 · 9 APR · SHIFT 2

(a) 4.13 eV (b) 1 eV (c) 7.26 eV (d) 3.13 eV

92. When UV light of wavelength 300 nm is incident on the metal surface having work function 2.13 eV , electron emission takes place. The stopping potential is:
(Given hc = 1240 eV nm)

JEE MAIN 2024 · 6 APR · SHIFT 2

(a) 4 V (b) 2 V (c) 4.1 V (d) 1.5 V

93. In photoelectric experiment energy of 2.48 eV irradiates a photo sensitive material. The stopping potential was measured to be 0.5 V. Work function of the photo sensitive material is:

JEE MAIN 2024 · 6 APR · SHIFT 1

(a) 1.98 eV (b) 1.68 eV (c) 2.48 eV (d) 0.5 eV

94. In a photoelectric effect experiment the threshold wavelength of the light is 380 nm. If the wavelentgh of incident light is 260 nm, the maximum kinetic energy of emitted electrons will be: Given E (in eV) = 1237/λ (in nm)

JEE MAIN 2019 · 10 APR · SHIFT 1

(a) 4.5 eV (b) 15.1 eV (c) 3.0 eV (d) 1.5 eV

95. The surface of a metal is illuminated with the light of 400 nm. The kinetic energy of the ejected photoelectrons was found to be 1.68 eV. The work function of the metal is: $(hc = 1240eV.nm)$

AIEEE 2009

(a) 1.41 eV (b) 1.51 eV (c) 1.68 eV (d) 3.09 eV

96. The threshold frequency for a metallic surface corresponds to an energy of 6.2 eV and the stopping potential for a radiation incident on this surface is 5V. The incident radiation lies in

AIEEE 2006

(a) ultra-violet region (b) infra-red region
(c) visible region (d) x-ray region

◆ Maximum speed of photoelectrons 18 Qs

97. In case of photoelectric emission from certain metal, the cutoff frequency is ν. If the radiation of frequency 3ν is incident on the metal plate, the maximum possible velocity of the emitted electrons will be (m = mass of electron, h = Planck's constant)

MHT CET 2026 · 18 APR · SHIFT 1

(a) $\sqrt{\frac{h\nu}{2m}}$ (b) $\sqrt{\frac{h\nu}{m}}$
(c) $2\left(\sqrt{\frac{h\nu}{m}}\right)$ (d) $\sqrt{\frac{2h\nu}{m}}$

98. Energy of the incident photons on the photosensitive metal surface is 3W and then 5W where 'W' is the work function of that metal. The ratio of velocities of the emitted photoelectrons is

MHT CET 2026 · 13 APR · SHIFT 1

(a) 1 : 1 (b) 1 : $\sqrt{2}$ (c) 1 : 2 (d) 1 : 4

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99. Energy of the incident photons on the metal surface is initially 4 W and then 6 W where W is the work function of that metal. The ratio of velocities of emitted photoelectrons is

MHT CET 2025 · 5 MAY · SHIFT 2

(a) $\sqrt{3}:\sqrt{5}$ (b) $1:2$ (c) $2:3$ (d) $\sqrt{2}:\sqrt{3}$

100. Photoelectric emission takes place from a certain metal at threshold frequency v. If the radiation of frequency $4v$ is incident on the metal plate, the maximum velocity of the emitted photoelectrons will be ($m=$ mass of photoelectron, $h=$ Planck's constant)

MHT CET 2025 · 22 APR · SHIFT 2

(a) $\sqrt{\frac{6hv}{m}}$ (b) $\sqrt{\frac{3hv}{m}}$ (c) $\sqrt{\frac{hv}{m}}$ (d) $\sqrt{\frac{5hv}{m}}$

101. When photons of energies twice and thrice the work function of a metal are incident on the metal surface one after other, the maximum velocities of the photoelectrons emitted in the two cases are V_1 and V_2 respectively. The ratio $V_1 : V_2$ is

MHT CET 2025 · 21 APR · SHIFT 2

(a) $\sqrt{3}:\sqrt{2}$ (b) $\sqrt{2}:1$ (c) $\sqrt{3}:1$ (d) $1:\sqrt{2}$

102. Two photons having energies twice and thrice the work function of metal are incident one after another on the metal surface. Then the ratio of maximum velocities of the photoelectrons emitted in the two cases is respectively

MHT CET 2024 · 15 MAY · SHIFT 1

(a) $\sqrt{3}:3$ (b) $\sqrt{2}:\sqrt{3}$ (c) $1:\sqrt{2}$ (d) $\sqrt{3}:1$

103. Radiations of two photons having energies twice and five times the work function of metal are incident successively on metal surface. The ratio of the maximum velocity of photo electrons emitted in the two cases will be

MHT CET 2023 · 12 MAY · SHIFT 1

(a) 1: 1 (b) 1: 2 (c) 1: 3 (d) 1: 4

104. When photons of energies twice and thrice the work function of a metal are incident on the metal surface one after other, the maximum velocities of the photoelectrons emitted in the two cases are v_1 and v_2 respectively. The ratio $v_1 : v_2$ is

MHT CET 2023 · 9 MAY · SHIFT 2

(a) $\sqrt{2}:1$ (b) $\sqrt{3}:1$ (c) $\sqrt{3}:\sqrt{2}$ (d) $1:\sqrt{2}$

105. Energy of the incident photon on the metal surface is $3W$ and then $5W$, where W is the work function for that metal. The ratio of velocities of emitted photoelectrons is

MHT CET 2020 · 16 OCT · SHIFT 1

(a) $1:4$ (b) $1:2$ (c) $1:\sqrt{2}$ (d) $1:1$

106. For photoelectric emission from certain metal the cutoff frequency is v. If radiation of frequency $2v$ impinges on the metal plate, the maximum possible velocity of the emitted electron will be (m is the electron mass)

NEET 2013

(a) $\sqrt{\frac{2hv}{m}}$ (b) $2\sqrt{\frac{hv}{m}}$ (c) $\sqrt{\frac{hv}{(2m)}}$ (d) $\sqrt{\frac{hv}{m}}$

107. Two radiations of photons energies 1 eV and 2.5 eV, successively illuminate a photosensitive metallic surface of work function 0.5 eV. The ratio of the maximum speeds of the emitted electrons is

AIPMT 2012 · MAINS

(a) 1: 4 (b) 1: 2 (c) 1: 1 (d) 1: 5

108. Light of two different frequencies whose photons have energies 1 eV and 2.5 eV respectively illuminate a metallic surface whose work function is 0.5 eV successively. Ratio of maximum speeds of emitted electrons will be

AIPMT 2011 · PRELIMS

(a) 1: 4 (b) 1: 2 (c) 1: 1 (d) 1: 5

109. Two streams of photons, possessing energies equal to five and ten times the work function of metal are incident on the metal surface successively. The ratio of maximum velocities of the photoelectron emitted, in the two cases respectively, will be

JEE MAIN 2022 · 28 JUL · SHIFT 2

(a) 1: 2 (b) 1: 3 (c) 2: 3 (d) 3: 2

110. The light of two different frequencies whose photons have energies 3.8 eV and 1.4 eV respectively, illuminate a metallic surface whose work function is 0.6 eV successively. The ratio of maximum speeds of emitted electrons for the two frequencies respectively will be:

JEE MAIN 2022 · 24 JUN · SHIFT 2

(a) 1: 1 (b) 2: 1 (c) 4: 1 (d) 1: 4

111. Two identical photocathodes receive the light of frequencies f_1 and f_2 respectively. If the velocities of the photo-electrons coming out are v_1 and v_2 respectively, then

JEE MAIN 2021 · 17 MAR · SHIFT 2

(a) $v_1 - v_2 = \left[\frac{2h}{m}(f_1 - f_2)\right]^{\frac{1}{2}}$

(b) $v_1^2 + v_2^2 = \frac{2h}{m}[f_1 + f_2]$

(c) $v_1 + v_2 = \left[\frac{2h}{m}(f_1 + f_2)\right]^{\frac{1}{2}}$

(d) $v_1^2 - v_2^2 = \frac{2h}{m}[f_1 - f_2]$

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112. Two identical photo-cathodes receive light of frequencies f_1 and f_2. If the velocities of the photo electrons (of mass m) coming out are respectively v_1 and v_2, then

AIEEE 2003

(a) $v_1^2 - v_2^2 = \frac{2h}{m}(f_1 - f_2)$

(b) $v_1 + v_2 = \left[\frac{2h}{m}(f_1 + f_2)\right]^{1/2}$

(c) $v_1^2 + v_2^2 = \frac{2h}{m}(f_1 + f_2)$

(d) $v_1 - v_2 = \left[\frac{2h}{m}(f_1 - f_2)\right]^{1/2}$

113. Two streams of photons, possessing energies equal to twice and ten times the work function of metal are incident on the metal surface successively. The value of ratio of maximum velocities of the photoelectrons emitted in the two respective cases is x: y. The value of x is _____.

JEE MAIN 2021 · 26 FEB · SHIFT 2 ***(Numerical)***

114. The surface of a metal is illuminated alternately with photons of energies $E_1 = 4$ eV and $E_2 = 2.5$ eV respectively. The ratio of maximum speeds of the photoelectrons emitted in the two cases is 2. The work function of the metal in (eV) is _____.

JEE MAIN 2020 · 5 SEP · SHIFT 2 ***(Numerical)***

◆ Changing frequency or wavelength: KE ratios 6 Qs

115. When photons of energy $h\nu$ fall on a metal plate of work function W_0, photoelectrons of maximum kinetic energy K are ejected. If the frequency of radiation is doubled, the maximum kinetic energy of ejected photoelectrons will be

MHT CET 2026 · 14 MAY · SHIFT 2

(a) $K + W_0$ (b) $K + h\nu$ (c) K (d) $2K$

116. The frequency of the incident light falling on a photosensitive metal plate is doubled, the kinetic energy of the emitted photoelectrons is

MHT CET 2026 · 13 MAY · SHIFT 1

(a) double the earlier value
(b) unchanged
(c) more than double
(d) less than double

117. The frequency of incident light falling on a photosensitive material is doubled, the K.E. of the emitted photoelectrons will be

MHT CET 2024 · 3 MAY · SHIFT 2

(a) unchanged.
(b) two times its initial value.
(c) more than two times its initial value.
(d) less than two times its initial value.

118. When photons of energy hv fall on a photosensitive surface of work function E_0, photoelectrons of maximum energy k are emitted. If the frequency of radiation is doubled the maximum kinetic energy will be equal to (h = Planck's constant)

MHT CET 2024 · 3 MAY · SHIFT 1

(a) k (b) 2 k (c) $k + E_0$ (d) $k + h\nu$

119. When photons of energy $h\upsilon$ fall on a metal plate of work function ' W_0 ', photoelectrons of maximum kinetic energy ' K ' are ejected. If the frequency of the radiation is doubled, the maximum kinetic energy of the ejected photoelectrons will be

MHT CET 2019 · 2 MAY · SHIFT 1

(a) $K + W_0$ (b) $K + h\upsilon$ (c) K (d) 2K

120. When photons of energy $h\upsilon$ fall on an aluminimum plate (of work function E_0), photoelectrons of maximum kinetic energy K are ejected. If the frequency of radiation is doubled, the maximum kinetic energy of the ejected photoelectrons will be

AIPMT 2006

(a) $K + h\upsilon$ (b) $K + E_0$ (c) 2K (d) K.

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TOPIC 04

Photoelectric Experiment: Intensity, Stopping Potential & Graphs

57 PYQs · Easy 57 · Medium 0 · Difficult 0 | MHT CET 26 · NEET 12 · JEE 19

Concepts covered: Effect of intensity & frequency (24) · What stopping potential depends on (11) · Graphs: photocurrent vs anode potential (2) · Graphs: stopping potential & KE vs frequency (17) · Photocurrent numericals & source distance (3)

LEVEL 1 · EASY 57 questions

◆ Effect of intensity & frequency 24 Qs

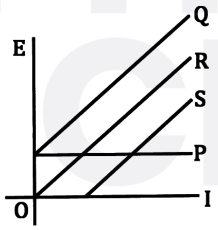
121. In photoelectric effect, keeping the frequency of incident radiation and accelerating potential fixed, if the intensity of incident light is increased,

MHT CET 2026 · 17 APR · SHIFT 2

(a) the photoelectric current increases.
(b) the kinetic energy of emitted photoelectrons increases.
(c) photoelectric current decreases.
(d) kinetic energy of emitted photoelectrons decreases.

122. Which one of the four graphs showing lines P, Q, R and S between maximum kinetic energy (E) and intensity of incident radiation (I) is correct?

MHT CET 2026 · 13 APR · SHIFT 1



(a) P (b) Q (c) R (d) S

123. From photoelectric effect experiment, select the correct statement.

MHT CET 2025 · 22 APR · SHIFT 1

(a) Photoelectric effect can be explained using wave theory of light.
(b) The maximum kinetic energy of a photoelectron depends on the intensity of incident light.
(c) The stopping potential depends only on the work function of the metal.
(d) The saturation current increases as the intensity of incident light increases.

124. In a photoelectric experiment, if the intensity of incident light is doubled and the frequency is kept slightly greater than threshold frequency, then the saturation photoelectric current

MHT CET 2025 · 19 APR · SHIFT 1

(a) remains constant (b) is halved
(c) is doubled (d) becomes four times

125. In photoelectric effect, the photocurrent

MHT CET 2024 · 10 MAY · SHIFT 1

(a) decreases with increase in frequency of incident photon.
(b) increases with increase in frequency of incident photon.
(c) does not depend on the frequency of photon but depends only on the intensity of incident light.
(d) depends both on intensity and frequency of incident radiation.

126. The number of photoelectrons emitted for light of frequency v (higher than the threshold frequency (v_0) is proportional to

MHT CET 2024 · 2 MAY · SHIFT 2

(a) threshold frequency (v_0)
(b) intensity of light (I)
(c) frequency of light (v)
(d) work function (ϕ_0)

127. The maximum kinetic energy of the photoelectrons varies

MHT CET 2023 · 10 MAY · SHIFT 2

(a) inversely with the intensity of incident radiation and is independent of its frequency.
(b) inversely with the frequency of incident radiation and is independent of its intensity.
(c) linearly with the frequency of incident radiation and depends on its intensity
(d) linearly with the frequency of incident radiation and is independent of its intensity.

128. In photoelectric experiment keeping the frequency of incident radiation and accelerating potential fixed, if the intensity of incident light is increased,

MHT CET 2021 · 24 SEP · SHIFT 1

(a) photoelectric current decreases
(b) kinetic energy of emitted photoelectrons decreases
(c) photoelectric current increases
(d) kinetic energy of emitted photoelectrons increases

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129. In photoelectric effect, the photo current
MHT CET 2021 · 23 SEP · SHIFT 2
(a) does not depend on the frequency of photon but depends on intensity of incident light.
(b) decreases with Increase in frequency of incident photon.
(c) increases with increase in frequency of incident photon.
(d) depends with on intensity of incident radiation and its frequency.

130. A metal surface is illuminated by light of given intensity and frequency to cause photoemission. If the intensity of illumination is reduced to one fourth of its original value then the maximum KE of the emitted photoelectrons would be
MHT CET 2019 · 2 MAY · SHIFT 2
(a) twice the original value
(b) four times the original value
(c) one fourth of the original value
(d) unchanged

131. The maximum kinetic energy of the emitted photoelectrons in photoelectric effect is independent of:
NEET 2023
(a) work function of material
(b) intensity of incident radiation
(c) frequency of incident radiation
(d) wavelength of incident radiation

132. When monochromatic radiation of intensity I falls on a metal surface, the number of photoelectrons and their maximum kinetic energy are N and T respectively. If the intensity of radiation is $2I$, the number of emitted electrons and their maximum kinetic energy are respectively
AIPMT 2010 · MAINS
(a) N and 2T (b) 2N and T (c) 2N and 2T (d) N and T

133. The number of photo electrons emitted for light of a frequency υ (higher than the threshold frequency υ_0) is proportional to
AIPMT 2009
(a) threshold frequency (υ_0)
(b) intensity of light
(c) frequency of light (υ_0)
(d) $\upsilon - \upsilon_0$

134. A photocell employs photoelectric effect to convert
AIPMT 2006
(a) change in the frequency of light into a change in the electric current
(b) change in the frequency of light into a change in electric voltage
(c) change in the intensity of illumination into a change in photoelectric current
(d) change in the intensity of illumination into a change in the work function of the photocathode.

135. When intensity of incident light increases
AIPMT 1999
(a) photo-current increases
(b) photo-current decreases
(c) kinetic energy of emitted photoelectrons increases
(d) kinetic energy of emitted photoelectrons decreases

136. Which of the following statement is correct?
AIPMT 1997
(a) The photocurrent increases with intensity of light
(b) The stopping potential increases with increase of incident light
(c) The current in photocell increases with increasing frequency
(d) The photocurrent is proportional to the applied voltage.

137. Number of ejected photoelectrons increases with increase
AIPMT 1993
(a) in intensity of light
(b) in wavelength of light
(c) in frequency of light
(d) never

138. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason **R**
Assertion A: In photoelectric effect, on increasing the intensity of incident light the stopping potential increases.
Reason R: Increase in intensity of light increases the rate of photoelectrons emitted, provided the frequency of incident light is greater than threshold frequency.
In the light of the above statements, choose the correct answer from the options given below
JEE MAIN 2025 · 4 APR · SHIFT 1
(a) Both **A** and **R** are true and **R** is the correct explanation of **A**
(b) **A** is false but **R** is true
(c) Both **A** and **R** are true but **R** is NOT the correct explanation of **A**
(d) **A** is true but **R** is false

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139. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A): Emission of electrons in photoelectric effect can be suppressed by applying a sufficiently negative electron potential to the photoemissive substance.

Reason (R): A negative electric potential, which stops the emission of electrons from the surface of a photoemissive substance, varies linearly with frequency of incident radiation.

In the light of the above statements, choose the most appropriate answer from the options given below:

JEE MAIN 2025 · 29 JAN · SHIFT 1

(a) Both (A) and (R) are true and (R) is the correct explanation of (A).
(b) Both (A) and (R) are true but (R) is not the correct explanation of (A).
(c) (A) is false but (R) is true
(d) (A) is true but (R) is false

140. In photo electric effect

A. The photocurrent is proportional to the intensity of the incident radiation

B. Maximum Kinetic energy with which photoelectrons are emitted depends on the intensity of incident light.

C. Max. K.E with which photoelectrons are emitted depends on the frequency of incident light. D. The emission of photoelectrons require a minimum threshold intensity of incident radiation. E. Max. K.E of the photoelectrons is independent of the frequency of the incident light. Choose the correct answer from the options given below:

JEE MAIN 2023 · 8 APR · SHIFT 2

(a) A and E only (b) A and B only
(c) B and C only (d) A and C only

141. From the photoelectric effect experiment, following observations are made. Identify which of these are correct.

A. The stopping potential depends only on the work function of the metal.

B. The saturation current increases as the intensity of incident light increases.

C. The maximum kinetic energy of a photo electron depends on the intensity of the incident light. D. Photoelectric effect can be explained using wave theory of light.

Choose the correct answer from the options given below:

JEE MAIN 2023 · 24 JAN · SHIFT 1

(a) A, B, D only (b) A, C, D only
(c) B, C only (d) B only

142. With reference to the observations in photo-electric effect, identify the correct statements from below:

(A) The square of maximum velocity of photoelectrons varies linearly with frequency of incident light.

(B) The value of saturation current increases on moving the source of light away from the metal surface.

(C) The maximum kinetic energy of photo-electrons decreases on decreasing the power of LED (light emitting diode) source of light.

(D) The immediate emission of photo-electrons out of metal surface can not be explained by particle nature of light/electromagnetic waves.

(E) Existence of threshold wavelength can not be explained by wave nature of light/ electromagnetic waves.

Choose the correct answer from the options given below:

JEE MAIN 2022 · 27 JUL · SHIFT 2

(a) (A) and (B) only (b) (A) and (E) only
(c) (C) and (E) only (d) (D) and (E) only

143. In a photoelectric experiment, increasing the intensity of incident light:

JEE MAIN 2021 · 27 AUG · SHIFT 1

(a) increases the number of photons incident and also increases the K.E. of the ejected electrons
(b) increases the frequency of photons incident and increases the K.E. of the ejected electrons
(c) increases the frequency of photons incident and the K.E. of the ejected electrons remains unchanged
(d) increases the number of photons incident and the K.E. of the ejected electrons remains unchanged

144. The time taken by a photoelectron to come out after the photon strikes is approximately

AIEEE 2006

(a) $10^{-4}\ s$ (b) $10^{-10}\ s$ (c) $10^{-16}\ s$ (d) $10^{-1}\ s$

◆ What stopping potential depends on 11 Qs

145. A point source of light is used in a photoelectric effect. If the source is moved farther from the emitting metal, then the stopping potential

MHT CET 2026 · 13 MAY · SHIFT 2

(a) will increase
(b) will decrease
(c) will remain constant
(d) will either increase or decrease

146. In photoelectric effect experiment, if the frequency of incident radiation (v) is increased, keeping all other factors constant, the stopping potential, ($v > v_0$) (v_0 = threshold frequency)

MHT CET 2026 · 15 APR · SHIFT 2

(a) decreases (b) remains the same
(c) increases (d) becomes zero

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147. A point source of light is used in a photoelectric effect. If the source is removed farther from the emitting metal, then the stopping potential will
MHT CET 2024 · 16 MAY · SHIFT 2
(a) increase.
(b) decrease.
(c) remain constant.
(d) either increase or decrease.

148. If the frequency of incident radiation (ν) is increased, keeping other factors constant, the stopping potential ($\nu > \nu_0$, threshold frequency)
MHT CET 2024 · 11 MAY · SHIFT 1
(a) increases (b) decreases
(c) remains constant (d) suddenly becomes zero

149. On a photosensitive surface, if the intensity of incident radiation is increased, the stopping potential
MHT CET 2021 · 21 SEP · SHIFT 1
(a) first increases and then decreases
(b) decreases
(c) increases
(d) remains unchanged

150. The stopping potential of the photoelectrons, from a photo cell is
MHT CET 2019 · 3 MAY · SHIFT 1
(a) directly proportional to intensity of incident light
(b) directly proportional to frequency of incident light
(c) inversely proportional to frequency of incident light
(d) Inversely proportional to intensity of incident light

151. A source of light is placed at a distance of 50 cm from a photo cell and the stopping potential is found to be V_0. If the distance between the light source and photo cell is made 25 cm, the new stopping potential will be:
NEET 2013
(a) $V_0/2$ (b) V_0 (c) $4V_0$ (d) $2V_0$

152. In an experiment with photoelectric effect, the stopping potential,
JEE MAIN 2025 · 29 JAN · SHIFT 2
(a) is $\left(\frac{1}{e}\right)$ times the maximum kinetic energy of the emitted photoelectrons
(b) increases with increase in the intensity of the incident light
(c) decreases with increase in the intensity of the incident light
(d) increases with increase in the wavelength of the incident light

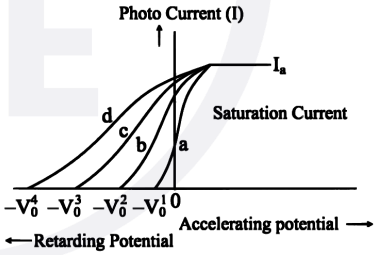
153. Which of the following statement is not true about stopping potential (V_0)?
JEE MAIN 2024 · 5 APR · SHIFT 2
(a) It depends upon frequency of the incident light.
(b) It is $1/e$ times the maximum kinetic energy of electrons emitted.
(c) It increases with increase in intensity of the incident light.
(d) It depends on the nature of emitter material.

154. Given below are two statements:
Statement I: Stopping potential in photoelectric effect does not depend on the power of the light source.
Statement II: For a given metal, the maximum kinetic energy of the photoelectron depends on the wavelength of the incident light.
In the light of above statements, choose the most appropriate answer from the options given below
JEE MAIN 2023 · 25 JAN · SHIFT 2
(a) Both Statement I and Statement II are incorrect
(b) Statement I is correct but Statement II is incorrect
(c) Both Statement I and Statement II are correct
(d) Statement I is incorrect but Statement II is correct

155. The stopping potential in the context of photoelectric effect depends on the following property of incident electromagnetic radiation:
JEE MAIN 2021 · 16 MAR · SHIFT 1
(a) Phase (b) Frequency
(c) Amplitude (d) Intensity

◆ Graphs: photocurrent vs anode potential 2 Qs

156. The figure shows the variation of photocurrent with anode potential for four different radiations. Let f_a, f_b, f_c and f_d be the frequencies for the curves a, b, c and d respectively
MHT CET 2024 · 9 MAY · SHIFT 2

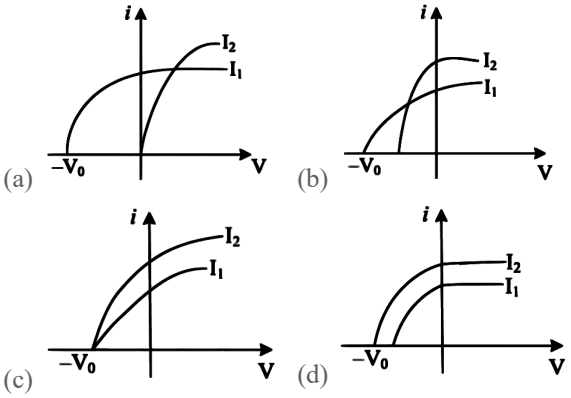


(a) $f_a > f_b > f_c > f_d$ (b) $f_a < f_b < f_c < f_d$
(c) $f_a > f_b < f_c = f_d$ (d) $f_a = f_b > f_c > f_d$

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157. Which figure shows the correct variation of applied potential difference (V) with photoelectric current (I) at two different intensities of light $(I_1 < I_2)$ of same wavelengths:

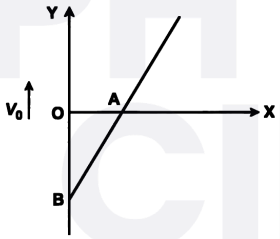
JEE MAIN 2024 · 4 APR · SHIFT 1



◆ Graphs: stopping potential & KE vs frequency 17 Qs

158. In an experiment on photoelectric effect, the stopping potential V_0 is plotted against the frequency ν of the incident light. Considering e as the electronic charge, the work function of the photoelectric surface is given by

MHT CET 2026 · 19 MAY · SHIFT 1



(a) OA in eV
(b) OB in volt
(c) multiplication of (OB) and (e) in joules
(d) The slope of the line AB

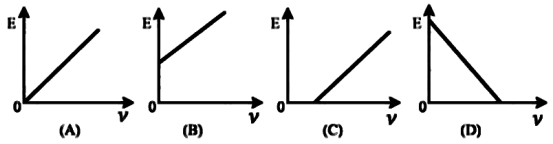
159. According to Einstein's photoelectric equation, the graph of the kinetic energy of the emitted photoelectrons versus the frequency of incident radiation gives a straight line whose slope

MHT CET 2026 · 19 APR · SHIFT 1

(a) depends on the intensity of incident radiation.
(b) depends on the nature of the metal used.
(c) is the same for all metals and independent of the intensity of radiation.
(d) depends on both the intensity of incident radiation and the nature of metal used.

160. Using Einstein's photoelectric equation, the graphical representation between the kinetic energy (E) of emitted Photoelectrons and the frequency of incident radiation (ν) is show correctly in figure

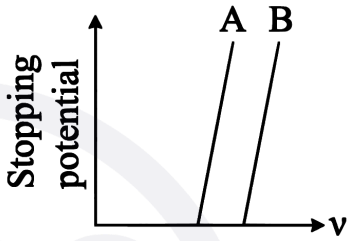
MHT CET 2026 · 16 APR · SHIFT 1



(a) A (b) B (c) C (d) D

161. The stopping potential as a function of frequency of incident radiation is plotted for two different photoelectric surfaces A and B. The graph shows that the work function of A is

MHT CET 2024 · 15 MAY · SHIFT 2



(a) greater than that of B.
(b) smaller than that of B.
(c) same as that of B.
(d) that no comparison can be made from the graphs.

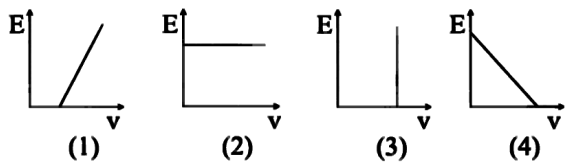
162. In case of photoelectric effect, the graph of measured stopping potential (V_0) against frequency ' υ ' of incident light is a straight line. The slope of this line multiplied by the charge of electron (e) gives

MHT CET 2024 · 11 MAY · SHIFT 2

(a) the work function of the metal.
(b) the Planck's constant.
(c) the maximum kinetic energy of the ejected electrons.
(d) the threshold frequency for photoejection from the metal.

163. Using Einstein's photoelectric equation, the graph between kinetic energy of emitted photoelectrons and the frequency of incident radiation is shown correctly by graph

MHT CET 2024 · 9 MAY · SHIFT 2

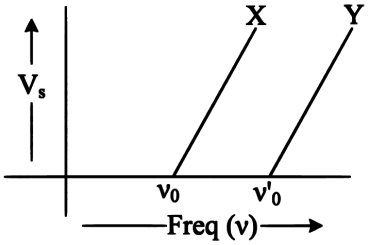


(a) 1 (b) 2 (c) 3 (d) 4

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164. The graph of stopping potential ' V_s ' against frequency ' v ' of incident radiation is plotted for two different metals ' X ' and ' Y ' as shown in graph. ' ϕ_x ' and ' ϕ_y ' are work functions of ' x ' and ' Y ' respectively then

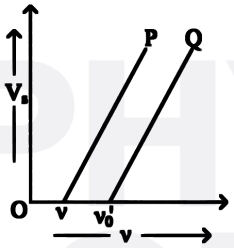
MHT CET 2024 · 3 MAY · SHIFT 2



(a) $\phi_x = \phi_y$ (b) $\phi_x < \phi_y$
(c) $\phi_x > \phi_y$ (d) $\phi_x = \phi_y = 0$

165. The graph of stopping potential V_s against frequency v of incident radiation is plotted for two different metals P and Q as shown in the graph. ϕ_p and ϕ_Q are work-functions of P and Q respectively, then

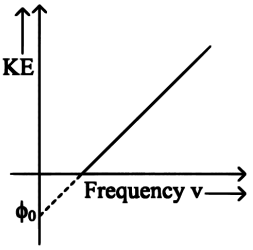
MHT CET 2020 · 19 OCT · SHIFT 2



(a) $\phi_P > \phi_Q$ (b) $\phi_P < \phi_Q$
(c) $\phi_P = \phi_Q$ (d) $\nu_0' < \nu_0$

166. The graph of kinetic energy against the frequency v of incident light is as shown in the figure. The slope of the graph and intercept on X-axis respectively are

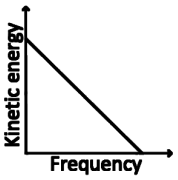
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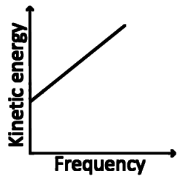


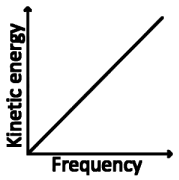
(a) maximum KE threshold frequency
(b) Planck's constant, threshold frequency
(c) Planck's constant, work function
(d) work function, maximum KE

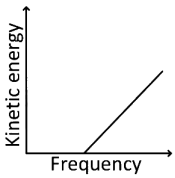
167. According to Einstein's photoelectric equation, the graph between the kinetic energy of photoelectrons ejected and the frequency of incident radiation is

AIPMT 2004

(a) 

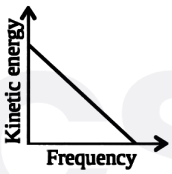
(b) 

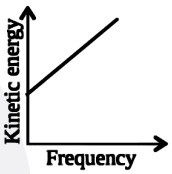
(c) 

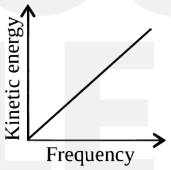
(d) 

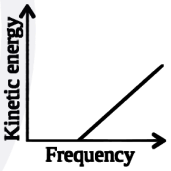
168. According to Einstein's photoelectric equation, the graph between the kinetic energy of photoelectrons ejected and the frequency of incident radiation is

AIPMT 1996

(a) 

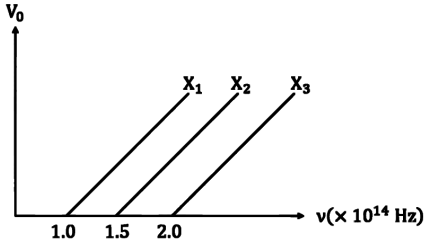
(b) 

(c) 

(d) 

169. The graph shows variation of stopping potential V_o with the frequency v of the incident radiation for three photosensitive metals X_1, X_2 and X_3. Which metal will give out electrons with greater kinetic energy, for the same wavelength of incident radiation?

JEE MAIN 2026 · 4 APR · SHIFT 1



(a) X_1
(b) X_2
(c) X_3
(d) All the metals will give out photo electrons with same kinetic energies.

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170. In photoelectric effect, the stopping potential (V_0)v/s frequency (v) curve is plotted. (h is the Planck's constant and ϕ_0 is work function of metal)

(A) V_0v/sv is linear.

(B) The slope of V_0v/sv curve $= \frac{\phi_0}{h}$

(C) h constant is related to the slope of V_0v/sv line.

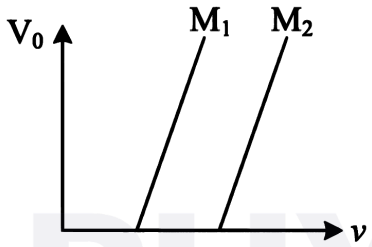
(D) The value of electric charge of electron is not required to determine h using the V_0v/sv curve. (E) The work function can be estimated without knowing the value of h.

Choose the correct answer from the options given below:

JEE MAIN 2025 · 24 JAN · SHIFT 2

(a) (A), (C) and (E) only (b) (C) and (D) only
(c) (A), (B) and (C) only (d) (D) and (E) only

171. Given below are two statements:



Statement I: Figure shows the variation of stopping potential with frequency (v) for the two photosensitive materials M_1 and M_2. The slope gives value of $\frac{h}{e}$, where h is Planck's constant, e is the charge of electron.

Statement II: M_2 will emit photoelectrons of greater kinetic energy for the incident radiation having same frequency.

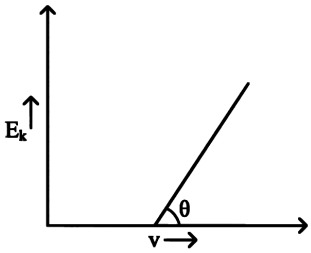
In the light of the above statements, choose the most appropriate answer from the options given below.

JEE MAIN 2024 · 5 APR · SHIFT 1

(a) Statement I is correct and Statement II is incorrect
(b) Statement I is incorrect but Statement II is correct
(c) Both Statement I and Statement II are correct
(d) Both Statement I and Statement II are incorrect

172. For the photoelectric effect, the maximum kinetic energy (E_k) of the photoelectrons is plotted against the frequency (v) of the incident photons as shown in figure. The slope of the graph gives

JEE MAIN 2024 · 30 JAN · SHIFT 2



(a) Planck's constant
(b) Work function of the metal
(c) Charge of electron
(d) Ratio of Planck's constant to electric charge

173. The work functions of Aluminium and Gold are 4.1 eV and 5.1 eV respectively. The ratio of the slope of the stopping potential versus frequency plot for Gold to that of Aluminium is

JEE MAIN 2023 · 6 APR · SHIFT 2

(a) 1.5 (b) 1.24 (c) 1 (d) 2

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

AIEEE 2004

(a) depends both on the intensity of the radiation and the metal used
(b) depends on the intensity of the radiation
(c) depends on the nature of the metal used
(d) is the same for all metals and independent of the intensity of the radiation

◆ Photocurrent numericals & source distance 3 Qs

175. A photoelectric cell is illuminated by a point source of light 1 m away. When the source is shifted to 2 m then

AIPMT 2003

(a) each emitted electron carries one quarter of the initial energy
(b) number of electrons emitted is half the initial number
(c) each emitted electron carries half the initial energy
(d) number of electrons emitted is a quarter of the initial number

176. A photo-cell is illuminated by a source of light, which is placed at a distance d from the cell. If the distance become d/2, then number of electrons emitted per second, will be

AIPMT 2001

(a) remain same (b) four times
(c) two times (d) one-fourth

177. A photocell is illuminated by a small bright source placed $1\ m$ away. When the same source of light is placed $\frac{1}{2}\ m$ away, the number of electrons emitted by photo-cathode would

AIEEE 2005

(a) increases by a factor of 4
(b) decreases by a factor of 4
(c) increases by a factor of 2
(d) decreases by a factor of 2

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TOPIC 05

Matter Waves: de Broglie Wavelength

59 PYQs · Easy 59 · Medium 0 · Difficult 0 | MHT CET 18 · NEET 13 · JEE 28

Concepts covered: de Broglie wavelength, momentum & KE (19) · Particle accelerated through a potential (15) · Comparing electron, proton & alpha (23) · Thermal neutrons & gas molecules (1) · Photon vs electron (1)

LEVEL 1 · EASY 59 questions

◆ de Broglie wavelength, momentum & KE 19 Qs

178. Two particles A and B of masses m_1 and m_2 ($m_1 > m_2$) have the same de-Broglie wavelength, then
MHT CET 2026 · 14 MAY · SHIFT 1
(a) their momenta are the same
(b) their energies are the same
(c) momenta of A is less than the momenta of B
(d) energy of A is more than energy of B

179. The de-Broglie wavelength λ of a particle
MHT CET 2026 · 14 MAY · SHIFT 1
(a) is proportional to mass
(b) is proportional to momentum
(c) is inversely proportional to momentum
(d) does not depend on momentum

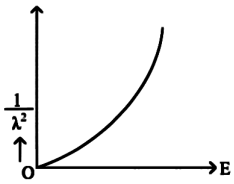
180. The kinetic energy of a free electron increases to 3 times the previous K.E. The ratio of new de- Broglie wavelength to previous de-Broglie wavelength is
MHT CET 2026 · 17 APR · SHIFT 1
(a) $\frac{1}{\sqrt{3}}$ (b) $\frac{1}{3}$ (c) 3 (d) $\sqrt{3}$

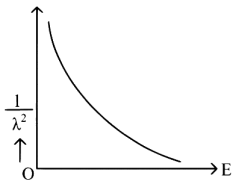
181. The de-Broglie wavelength (λ) of a particle
MHT CET 2025 · 21 APR · SHIFT 1
(a) is inversely proportional to impulse.
(b) does not depend on impulse.
(c) is proportional to mass.
(d) is proportional to impulse.

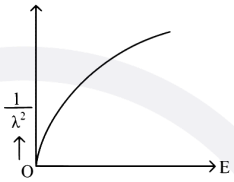
182. The kinetic energy of an electron is increased by 2 times, then the de-Broglie wavelength associated with it changes by a factor.
MHT CET 2024 · 4 MAY · SHIFT 2
(a) $\frac{1}{3}$ (b) $\frac{1}{\sqrt{3}}$ (c) 3 (d) $\sqrt{3}$

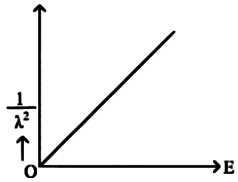
183. The de-Broglie wavelength (λ) of a particle is related to its kinetic energy (E) as
MHT CET 2023 · 14 MAY · SHIFT 1
(a) $\lambda \propto E$ (b) $\lambda \propto E^{-1}$ (c) $\lambda \propto E^{\frac{1}{2}}$ (d) $\lambda \propto E^{-\frac{1}{2}}$

184. If the kinetic energy of a free electron doubles, it's de Broglie wavelength (λ) changes by a factor
MHT CET 2022 · 11 AUG · SHIFT 2
(a) $\frac{1}{\sqrt{2}}$ (b) $\frac{1}{2}$ (c) $\sqrt{2}$ (d) 2

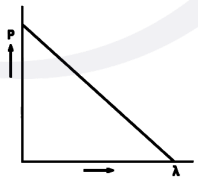
185. The graph which shows the variation of $\left(\frac{1}{\lambda^2}\right)$ and its kinetic energy, E is (where λ is de Broglie wavelength of a free particle):
NEET 2024
(a) 

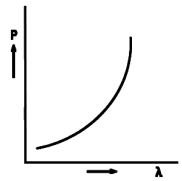
(b) 

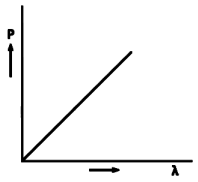
(c) 

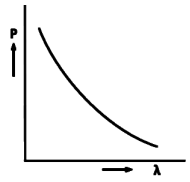
(d) 

186. The de Broglie wavelength of an electron moving with kinetic energy of 144 eV is nearly
NEET 2020 · PHASE 2
(a) 102×10^{-2} nm (b) 102×10^{-3} nm
(c) 102×10^{-4} nm (d) 102×10^{-5} nm

187. Which of the following figures represent the variation of particle momentum and the associated de- Broglie wavelength?
AIPMT 2015 · CANCELLED PAPER
(a) 

(b) 

(c) 

(d) 

188. An electron beam has a kinetic energy equal to 100 eV. Find its wavelength associated with a beam, if mass of electron $= 9.1 \times 10^{-31}$ kg and 1 eV $= 1.6 \times 10^{-19}$ J/eV.
(Planck's constant $= 6.6 \times 10^{-34}$ Js)
AIPMT 1996
(a) 24.6 Å (b) 0.12 Å (c) 1.2 Å (d) 6.3 Å

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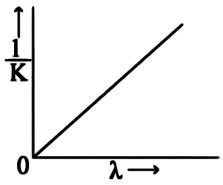
189. The de Broglie wave corresponding to a particle of mass m and velocity v has a wavelength associated with it

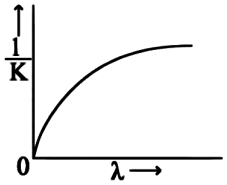
AIPMT 1989

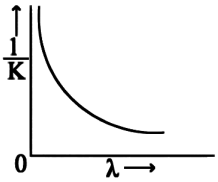
(a) $\frac{h}{mv}$ (b) hmv (c) $\frac{mh}{v}$ (d) $\frac{m}{hv}$

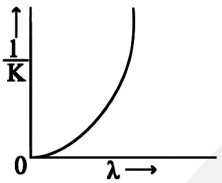
190. If λ and K are de Broglie wavelength and kinetic energy, respectively, of a particle with constant mass. The correct graphical representation for the particle will be:

JEE MAIN 2025 · 29 JAN · SHIFT 1

(a) 

(b) 

(c) 

(d) 

191. The de Broglie wavelength of an electron having kinetic energy E is λ. If the kinetic energy of electron becomes $\frac{E}{4}$, then its de-Broglie wavelength will be:

JEE MAIN 2023 · 15 APR · SHIFT 1

(a) $\sqrt{2}\lambda$ (b) 2λ (c) $\frac{\lambda}{2}$ (d) $\frac{\lambda}{\sqrt{2}}$

192. The equation $\lambda = \frac{1.227}{x}$ nm can be used to find the de-Brogli wavelength of an electron. In this equation x stands for:

Where

m = mass of electron

P = momentum of electron

K = Kinetic energy of electron

V = Accelerating potential in volts for electron

JEE MAIN 2022 · 28 JUL · SHIFT 1

(a) $\sqrt{mK}$ (b) $\sqrt{P}$ (c) $\sqrt{K}$ (d) $\sqrt{V}$

193. The de-Broglie wavelength of a particle having kinetic energy E is λ. How much extra energy must be given to this particle so that the de-Broglie wavelength reduces to 75% of the initial value?

JEE MAIN 2021 · 26 AUG · SHIFT 2

(a) $\frac{1}{9}$ E (b) $\frac{7}{9}$ E (c) E (d) $\frac{16}{9}$ E

194. A particle moving with kinetic energy E has de Broglie wavelength λ. If energy ΔE is added to its energy, the wavelength become $\lambda/2$. Value of ΔE, is:

JEE MAIN 2020 · 9 JAN · SHIFT 1

(a) E (b) 3E (c) 2E (d) 4E

195. For which of the following particles will it be most difficult to experimentally verify the de-Broglie relationship?

JEE MAIN 2014 · 9 APR · SHIFT 1

(a) an electron (b) a proton
(c) an α-particle (d) a dust particle

196. If the kinetic energy of a free electron doubles, it's deBroglie wavelength changes by the factor

AIEEE 2005

(a) 2 (b) $\frac{1}{2}$ (c) $\sqrt{2}$ (d) $\frac{1}{\sqrt{2}}$

◆ Particle accelerated through a potential 15 Qs

197. Electron beam when accelerated by a voltage of 10 kV, has a de-Broglie wavelength ' λ '. If the voltage is increased to 20 kV then the deBroglie wavelength associated with the electron beam would be

MHT CET 2025 · 23 APR · SHIFT 2

(a) 4λ (b) 2λ (c) $\frac{\lambda}{2}$ (d) $\frac{\lambda}{\sqrt{2}}$

198. An electron accelerated by a potential difference ' V ' has de-Broglie wavelength ' λ '. If the electron is accelerated by a potential difference ' 9 V ', its de-Broglie wavelength will be

MHT CET 2025 · 19 APR · SHIFT 2

(a) $\frac{\lambda}{4.5}$ (b) $\frac{\lambda}{3}$ (c) $\frac{\lambda}{2}$ (d) λ

199. Electrons are accelerated through a potential difference of 16 kV. If the potential difference is increased to 64 kV, then de-Broglie wavelength associated with electron will

MHT CET 2024 · 15 MAY · SHIFT 1

(a) remain same. (b) becomes half.
(c) becomes four time. (d) becomes quarter.

200. If the potential difference used to accelerate electrons is doubled. By what factor does the deBroglie wavelength (λ) associated with the electrons change?

MHT CET 2024 · 11 MAY · SHIFT 1

(a) λ is increased to $\sqrt{2}$ times.
(b) λ is increased to $\frac{1}{\sqrt{2}}$ times.
(c) λ is decreased to $\frac{1}{\sqrt{2}}$ times.
(d) λ is decreased to $\sqrt{2}$ times.

201. If the potential difference used to accelerate electrons is increased four times, by what factor does the de-Broglie wavelength associated with the electrons change?

MHT CET 2024 · 10 MAY · SHIFT 1

(a) Wavelength increased two times
(b) Wavelength decreased to half
(c) Wavelength increased four times
(d) Wavelength remains the same

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202. When an electron is accelerated through a potential 'V', the de-Broglie wavelength associated with it is '4λ'. When the accelerating potential is increased to 4 V, its wavelength will be

MHT CET 2023 · 12 MAY · SHIFT 2

(a) $\frac{\lambda}{4}$ (b) $\frac{\lambda}{2}$ (c) λ (d) 2λ

203. If the potential difference used to accelerate electrons is doubled, by what factor does the de- Broglie wavelength associated with electrons change?

MHT CET 2023 · 10 MAY · SHIFT 2

(a) Wavelength is increased to $\frac{1}{\sqrt{2}}$ times.

(b) Wavelength is increased to $\frac{1}{2}$ times.

(c) Wavelength is decreased to $\frac{1}{\sqrt{2}}$ times.

(d) Wavelength is decreased to $\frac{1}{2}$ times.

204. de-Broglie wavelength associated with an electron accelerated through a potential difference 'V' is 'λ'. When the accelerating potential is increased to '4 V', de-Broglie wavelength.

MHT CET 2021 · 23 SEP · SHIFT 2

(a) reduces to half (b) remains the same

(c) reduces to $(1/4)^{th}$ (d) increases by 25%

205. The de Broglie wavelength associated with an electron, accelerated by a potential difference of 81 V is given by:

NEET 2023

(a) 13.6 nm (b) 136 nm (c) 1.36 nm (d) 0.136 nm

206. An electron is accelerated from rest through a potential difference of V volt. If the de-Broglie wavelength of the electron is 1.227×10^{-2} nm, the potential difference is:

NEET 2020 · PHASE 1

(a) 102 V (b) 103 V (c) 104 V (d) 10 V

207. An electron is accelerated through a potential difference of 10,000 V. Its de Broglie wavelength is (nearly): ($m_e = 9 \times 10^{-31}$ kg)

NEET 2019

(a) 12.2 × 10–12 m (b) 12.2 × 10–13 m

(c) 12.2 × 10–14 m (d) 12.2 nm

208. Electrons used in an electron microscope are accelerated by a voltage of 25 kV. If the voltage is increased to 100 kV then the de-Broglie wavelength associated with the electrons would

AIPMT 2011 · PRELIMS

(a) increase by 2 times (b) decrease by 2 times

(c) decrease by 4 times (d) increase by 4 times

209. Electron beam used in an electron microscope, when accelerated by a voltage of 20 kV, has a de- Broglie wavelength of λ_0. IF the voltage is increased to 40 kV, then the de-Broglie wavelength associated with the electron beam would be:

JEE MAIN 2023 · 25 JAN · SHIFT 1

(a) $3\lambda_0$ (b) $9\lambda_0$ (c) $\frac{\lambda_0}{\sqrt{2}}$ (d) $\frac{\lambda_0}{2}$

210. The de Broglie wavelength associated with an electron, accelerated through a potential difference of 15056 V, is:

JEE MAIN 2022 · 30 JUL · SHIFT 2

(a) 0.1 Å (b) 1 Å (c) 10 Å (d) 100 Å

211. de-Broglie wavelength of an electron accelerated by a voltage of 50 V is close to ($|e| = 1.6 \times 10^{-19}$ C, $m_e = 9.1 \times 10^{-31}$ kg, $h = 6.6 \times 10^{-34}$ Js):

JEE MAIN 2015 · 10 APR · SHIFT 1

(a) 0.5 $\mathring{A}$ (b) 1.2 $\mathring{A}$ (c) 1.7 $\mathring{A}$ (d) 2.4 $\mathring{A}$

◆ Comparing electron, proton & alpha 23 Qs

212. The ratio of de-Broglie wavelength of an α-particle and proton accelerated from rest by the same potential is $\frac{1}{\sqrt{m}}$. The value of m is

MHT CET 2026 · 20 APR · SHIFT 2

(a) 2 (b) 8 (c) 4 (d) 5

213. The proton and α - particle are accelerated through same potential difference. Then the ratio of the de-Broglie wavelength of proton and α - particle is (mass of α-particle is 4 times mass of proton, charge of α-particle is 2 times charge of proton)

MHT CET 2026 · 20 APR · SHIFT 1

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

214. A proton and alpha particle are accelerated through the same potential difference. The ratio of the de-Broglie wavelength of proton to that of alpha particle will be (mass of alpha particle is four times mass of proton.)

MHT CET 2021 · 21 SEP · SHIFT 2

(a) 1 : 2 (b) $2\sqrt{2}$: 1 (c) 1 : 1 (d) 2 : 1

215. An electron and an alpha particle are accelerated by the same potential difference. Let λ_e and λ_α denote the de-Broglie wavelengths of the electron and the alpha particle, respectively, then:

NEET 2024

(a) $\lambda_e > \lambda_\alpha$ (b) $\lambda_e = 4\lambda_\alpha$

(c) $\lambda_e = \lambda_\alpha$ (d) $\lambda_e < \lambda_\alpha$

216. A proton and an α-particle are accelerated from rest to the same energy. The de Broglie wavelengths λ_p and λ_α are in the ratio,

NEET 2019

(a) 4 : 1 (b) 2 : 1 (c) 1 : 1 (d) $\sqrt{2}$: 1

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217. If particles are moving with same velocity, then which has maximum de Broglie wavelength?

AIPMT 2002

(a) proton (b) α-particle
(c) neutron (d) β-particle

218. A proton, an electron and an alpha particle have the same energies. Their de-Broglie wavelengths will be compared as:

JEE MAIN 2024 · 9 APR · SHIFT 1

(a) $\lambda_p > \lambda_e > \lambda_\alpha$ (b) $\lambda_\alpha < \lambda_p < \lambda_e$
(c) $\lambda_e > \lambda_\alpha > \lambda_p$ (d) $\lambda_p < \lambda_e < \lambda_\alpha$

219. A proton and an electron have the same de Broglie wavelength. If K_p and K_e be the kinetic energies of proton and electron respectively, then choose the correct relation:

JEE MAIN 2024 · 8 APR · SHIFT 2

(a) $K_p > K_e$ (b) $K_p = K_e$
(c) $K_p < K_e$ (d) $K_p = K_e^2$

220. The de Broglie wavelengths of a proton and an α particle are λ and 2λ respectively. The ratio of the velocities of proton and α particle will be:

JEE MAIN 2024 · 1 FEB · SHIFT 1

(a) 8 : 1 (b) 1 : 2 (c) 1 : 8 (d) 4 : 1

221. Proton (P) and electron (e) will have same de-Broglie wavelength when the ratio of their momentum is (assume, $m_p = 1849\, m_e$):

JEE MAIN 2023 · 8 APR · SHIFT 1

(a) 1: 1 (b) 1: 43 (c) 1: 1849 (d) 43: 1

222. The ratio of de-Broglie wavelength of an α particle and a proton accelerated from rest by the same potential is $\frac{1}{\sqrt{m}}$, the value of m is -

JEE MAIN 2023 · 29 JAN · SHIFT 2

(a) 2 (b) 16 (c) 8 (d) 4

223. An α-particle, a proton and an electron have the same kinetic energy. Which one of the following is correct in case of their de-Broglie wavelength:

JEE MAIN 2023 · 24 JAN · SHIFT 2

(a) $\lambda_\alpha > \lambda_p < \lambda_e$ (b) $\lambda_\alpha > \lambda_p > \lambda_e$
(c) $\lambda_\alpha = \lambda_p = \lambda_e$ (d) $\lambda_\alpha < \lambda_p < \lambda_e$

224. An α particle and a proton are accelerated from rest through the same potential difference. The ratio of linear momenta acquired by above two particles will be:

JEE MAIN 2022 · 29 JUL · SHIFT 2

(a) $\sqrt{2}$: 1 (b) $2\sqrt{2}$: 1 (c) $4\sqrt{2}$: 1 (d) 8: 1

225. An α particle and a carbon 12 atom has same kinetic energy K. The ratio of their de-Broglie wavelengths $(\lambda_\alpha : \lambda_{C12})$ is:

JEE MAIN 2022 · 27 JUN · SHIFT 1

(a) $1 : \sqrt{3}$ (b) $\sqrt{3} : 1$ (c) $3 : 1$ (d) $2 : \sqrt{3}$

226. A proton, a neutron, an electron and an α particle have same energy. If λ_p, λ_n, λ_e and λ_α are the de Broglie's wavelengths of proton, neutron, electron and α particle respectively, then choose the correct relation from the following:

JEE MAIN 2022 · 25 JUN · SHIFT 2

(a) $\lambda_p = \lambda_n > \lambda_e > \lambda_\alpha$ (b) $\lambda_\alpha < \lambda_n < \lambda_p < \lambda_e$
(c) $\lambda_e < \lambda_p = \lambda_n > \lambda_\alpha$ (d) $\lambda_e = \lambda_p = \lambda_n = \lambda_\alpha$

227. A moving proton and electron have the same de-Broglie wavelength. If K and P denote the K.E. and momentum respectively. Then choose the correct option:

JEE MAIN 2021 · 31 AUG · SHIFT 1

(a) $K_p < K_e$ and $P_p = P_e$ (b) $K_p = K_e$ and $P_p = P_e$
(c) $K_p < K_e$ an $P_p < P_e$ (d) $K_p > K_e$ and $P_p = P_e$

228. What should be the order of arrangement of de-Broglie wavelength of electron (λ_e), an α-particle (λ_a) and proton (λ_p) given that all have the same kinetic energy?

JEE MAIN 2021 · 25 JUL · SHIFT 1

(a) $\lambda_e = \lambda_p = \lambda_\alpha$ (b) $\lambda_e < \lambda_p < \lambda_\alpha$
(c) $\lambda_e > \lambda_p > \lambda_\alpha$ (d) $\lambda_e = \lambda_p > \lambda_\alpha$

229. An electron of mass m_e and a proton of mass m_p are accelerated through the same potential difference. The ratio of the de-Broglie wavelength associated with the electron to that with the proton is

JEE MAIN 2021 · 22 JUL · SHIFT 2

(a) $\frac{m_e}{m_p}$ (b) 1 (c) $\frac{m_p}{m_e}$ (d) $\sqrt{\frac{m_p}{m_e}}$

230. The de-Broglie wavelength associated with an electron and a proton were calculated by accelerating them through same potential of 100 V. What should nearly be the ratio of their wavelengths? (m_p = 1.00727u m_e = 0.00055u)

JEE MAIN 2021 · 16 MAR · SHIFT 2

(a) 41.4: 1 (b) (1860)2: 1
(c) 1860: 1 (d) 43: 1

231. An electron of mass m_e and a proton of mass m_p = 1836 m_e are moving with the same speed. The ratio of their de Broglie wavelength $\frac{\lambda electron}{\lambda proton}$ will be:

JEE MAIN 2021 · 25 FEB · SHIFT 2

(a) 1 (b) 1836 (c) $\frac{1}{1836}$ (d) 918

232. The de-Broglie wavelength of a proton and α-particle are equal. The ratio of their velocities is:

JEE MAIN 2021 · 24 FEB · SHIFT 2

(a) 4: 2 (b) 4: 3 (c) 4: 1 (d) 1: 4

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233. An electron, a doubly ionized helium ion (He^{++}) and a proton are having the same kinetic energy. The relation between their respective de-Broglie wavelengths λ_e, $\lambda_{He^{++}}$ and λ_p is:

JEE MAIN 2020 · 6 SEP · SHIFT 1

(a) $\lambda_e > \lambda_{He^{++}} > \lambda_p$ (b) $\lambda_e < \lambda_p < \lambda_{He^{++}}$

(c) $\lambda_e > \lambda_p > \lambda_{He^{++}}$ (d) $\lambda_e < \lambda_{He^{++}} = \lambda_p$

234. If the de Broglie wavelengths associated with a proton and an α-particle are equal, then the ratio of velocities of the proton and the α-particle will be:

JEE MAIN 2018 · 15 APR · SHIFT 2

(a) 4: 1 (b) 2: 1 (c) 1: 2 (d) 1: 4

◆ Thermal neutrons & gas molecules 1 Q

235. The de Broglie wavelength of a molecule in a gas at room temperature (300 K) is λ_1. If the temperature of the gas is increased to 600 K, then the de Broglie wavelength of the same gas molecule becomes

JEE MAIN 2023 · 10 APR · SHIFT 1

(a) $2\,\lambda_1$ (b) $\frac{1}{2}\lambda_1$ (c) $\frac{1}{\sqrt{2}}\lambda_1$ (d) $\sqrt{2}\,\lambda_1$

◆ Photon vs electron 1 Q

236. If we consider electrons and photons of same wavelength, then they will have same

AIPMT 1995

(a) momentum (b) angular momentum

(c) energy (d) velocity

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TOPIC 06

Davisson-Germer, Uncertainty, Compton & X-Rays

10 PYQs · Easy 10 · Medium 0 · Difficult 0 | MHT CET 0 · NEET 4 · JEE 6

Concepts covered: Davisson-Germer & electron microscope (7) · X-rays & cut-off wavelength (3)

LEVEL 1 · EASY 10 questions

◆ Davisson-Germer & electron microscope 7 Qs

237. The wave nature of electrons was experimentally verified by,

NEET 2020 · PHASE 2

(a) Davisson and Germer (b) de Broglie
(c) Hertz (d) Einstein

238. In the Davisson and Germer experiment, the velocity of electrons emitted from the electron gun can be increased by

AIPMT 2011 · PRELIMS *(Not in current JEE/NEET syllabus)*

(a) increasing the potential difference between the anode and filament
(b) increasing the filament current
(c) decreasing the filament current
(d) decreasing the potential difference between the anode and flament

239. Given below are two statements: one is labeled as Assertion A and the other is labelled as Reason R.

Assertion A: An electron microscope can achieve better resolving power than an optical microscope.

Reason R: The de Broglie's wavelength of the electrons emitted from an electron gun is much less than wavelength of visible light.

In the light of the above statements, choose the correct answer from the options given below:

JEE MAIN 2021 · 26 FEB · SHIFT 1

(a) A is false but R is true.
(b) Both A and R are true but R is NOT the correct explanation of A.
(c) Both A and R are true and R is the correct explanation of A.
(d) A is true but R is false.

240. Given below are two statements: One is labelled as Assertion A and the other is labelled as Reason R

Assertion A: The beam of electrons show wave nature and exhibit interference and diffraction. Reason R: Davisson Germer Experimentally verified the wave nature of electrons. In the light of the above statements, choose the most appropriate answer from the options given below:

JEE MAIN 2023 · 31 JAN · SHIFT 1 *(Not in current JEE/NEET syllabus)*

(a) A is not correct but R is correct.
(b) Both A and R are correct and R is the correct explanation of A
(c) Both A and R are correct but R is Not the correct explanation of A
(d) A is correct but R is not correct

241. Given below are two statements:

Statement I: Davisson-Germer experiment establishes the wave nature of electrons. Statement II: If electrons have wave nature, they can interfere and show diffraction. In the light of the above statements choose the correct answer from the option given below:

JEE MAIN 2022 · 25 JUN · SHIFT 1 *(Not in current JEE/NEET syllabus)*

(a) Both Statement I and Statement II are true.
(b) Both Statement I and Statement II are false.
(c) Statement I is true but Statement II is false.
(d) Statement I is false but Statement II is true.

242. Match List - I (Fundamental Experiment) with List - II (its conclusion) and select the correct option from the choices given below the list:

JEE MAIN 2015 *(Not in current JEE/NEET syllabus)*

List - I		List - II	
A.	Franck-Hertz	(i)	Particle nature of light
B.	Photo-electric	(ii)	Discrete energy levels of atom
C.	Davison-Germer experiment	(iii)	Wave nature of electron
		(iv)	Structure of atom

(a) $A-ii; B-i, C-iii$
(b) $A-iv; B-iii, C-ii$
(c) $A-i; B-iv, C-iii$
(d) $A-ii; B-iv, C-iii$

243. This question has Statement 1 and Statement 2. Of the four choices given after the statements, choose the one that best describes the two statements.

Statement 1: Davisson - Germer experiment established the wave nature of electrons. Statement 2: If electrons have wave nature, they can interfere and show diffraction.

AIEEE 2012 *(Not in current JEE/NEET syllabus)*

(a) Statement 1 is true, Statement 2 is false
(b) Statement 1 is true, Statement 2 is true, Statement 2 is the correct explanation for Statement 1.
(c) Statement 1 is true, Statement 2 is true, Statement 2 is not the correct explanation of Statement 1.
(d) Statement 1 is false, Statement 2 is true.

◆ X-rays & cut-off wavelength 3 Qs

244. The minimum wavelength of X-rays produced by an electron accelerated through a potential difference of V volts is proportional to:

NEET 2023

(a) $\frac{1}{V}$ (b) $\frac{1}{\sqrt{V}}$ (c) V^2 (d) $\sqrt{V}$

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245. The minimum wavelength of the X-rays produced by electrons accelerated through a potential difference of V volts is directly proportional to

AIPMT 1996 ***(Not in current JEE/NEET syllabus)***

(a) $\frac{1}{\sqrt{V}}$ (b) $\frac{1}{V}$ (c) $\sqrt{V}$ (d) V^2

246. An X-ray tube is operated at 1.24 million volt. The shortest wavelength of the produced photon will be:

JEE MAIN 2021 · 24 FEB · SHIFT 2

(a) 10^{-2} nm (b) 10^{-1} nm (c) 10^{-3} nm (d) 10^{-4} nm

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TOPIC 07

Other / Mixed: Atoms & Bohr Links

2 PYQs · Easy 2 · Medium 0 · Difficult 0 | MHT CET 0 · NEET 1 · JEE 1

Concepts covered: Atoms, Bohr model & other links (2)

LEVEL 1 · EASY 2 questions

247. An electron with (rest mass m_0) moves with a speed of $0.8\,c$. Its mass when it moves with this speed is

AIPMT 1991 *(Not in current JEE/NEET syllabus)*

(a) m_0 (b) $\frac{m_0}{6}$ (c) $\frac{5m_0}{3}$ (d) $\frac{3m_0}{5}$

248. Formation of covalent bonds in compounds exhibits

AIEEE 2002

(a) wave nature of electron
(b) particle nature of electron
(c) both wave and particle nature of electron
(d) none of these

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ANSWER KEY

Shaded by level: **Easy**

01 Cathode Rays, Thomson's Experiment & Gas Discharge

1. (a)	2. (c)	3. (a)	4. (d)	5. (c)	6. (b)	7. (c)	8. (a)	9. (b)	10. (b)

02 Photons: Energy, Momentum & Radiation Pressure

11. (c)	12. (a)	13. (b)	14. (a)	15. (d)	16. (a)	17. (b)	18. (c)	19. (Bonus)	20. (a)
21. (b)	22. (a)	23. (b)	24. (d)	25. (a)	26. (b)	27. (c)	28. (d)	29. (a)	30. (a)
31. (d)	32. (a)	33. (d)	34. (a)	35. (a)	36. (b)	37. (a)	38. (a)	39. (a)	40. (a)
41. (a)	42. (d)	43. (a)	44. (d)	45. (a)	46. (d)	47. (a)			

03 Photoelectric Effect: Einstein's Equation

48. (d)	49. (c)	50. (b)	51. (b)	52. (c)	53. (d)	54. (a)	55. (d)	56. (b)	57. (b)
58. (b)	59. (b)	60. (a)	61. (d)	62. (c)	63. (d)	64. (c)	65. (c)	66. (b)	67. (c)
68. (c)	69. (b)	70. (a)	71. (c)	72. (b)	73. (b)	74. (d)	75. (c)	76. (b)	77. (d)
78. (c)	79. (b)	80. (a)	81. (b)	82. (c)	83. (d)	84. (b)	85. (c)	86. (b)	87. (a)
88. (b)	89. (c)	90. (c)	91. (b)	92. (b)	93. (a)	94. (d)	95. (a)	96. (a)	97. (c)
98. (b)	99. (a)	100. (a)	101. (d)	102. (c)	103. (b)	104. (d)	105. (c)	106. (a)	107. (b)
108. (b)	109. (c)	110. (b)	111. (d)	112. (a)	113. 1	114. 2	115. (b)	116. (c)	117. (c)
118. (d)	119. (b)	120. (a)							

04 Photoelectric Experiment: Intensity, Stopping Potential & Graphs

121. (a)	122. (a)	123. (d)	124. (c)	125. (c)	126. (b)	127. (d)	128. (c)	129. (a)	130. (d)
131. (b)	132. (b)	133. (b)	134. (c)	135. (a)	136. (a)	137. (a)	138. (b)	139. (b)	140. (d)
141. (d)	142. (b)	143. (d)	144. (b)	145. (c)	146. (c)	147. (c)	148. (a)	149. (d)	150. (b)
151. (b)	152. (a)	153. (c)	154. (c)	155. (b)	156. (b)	157. (c)	158. (c)	159. (c)	160. (c)
161. (b)	162. (b)	163. (a)	164. (b)	165. (b)	166. (b)	167. (d)	168. (d)	169. (a)	170. (a)
171. (a)	172. (a)	173. (c)	174. (d)	175. (d)	176. (b)	177. (a)			

05 Matter Waves: de Broglie Wavelength

178. (a)	179. (c)	180. (a)	181. (a)	182. (b)	183. (d)	184. (a)	185. (d)	186. (b)	187. (d)
188. (c)	189. (a)	190. (d)	191. (b)	192. (d)	193. (b)	194. (b)	195. (d)	196. (d)	197. (d)
198. (b)	199. (b)	200. (c)	201. (b)	202. (d)	203. (c)	204. (a)	205. (d)	206. (c)	207. (a)
208. (b)	209. (c)	210. (a)	211. (c)	212. (b)	213. (d)	214. (b)	215. (a)	216. (b)	217. (d)
218. (b)	219. (c)	220. (a)	221. (a)	222. (c)	223. (d)	224. (b)	225. (b)	226. (b)	227. (a)
228. (c)	229. (d)	230. (d)	231. (b)	232. (c)	233. (c)	234. (a)	235. (c)	236. (a)	

06 Davisson-Germer, Uncertainty, Compton & X-Rays

237. (a)	238. (a)	239. (c)	240. (b)	241. (a)	242. (a)	243. (b)	244. (a)	245. (b)	246. (c)

07 Other / Mixed: Atoms & Bohr Links

247. (c)	248. (a)								

Note: *"Bonus" = no option is correct as the question is printed (dropped in the official key). Numerical questions show the numerical answer.*

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