DPP - Daily Practice Problems

Name :

Date :

Start Time :

End Time :

PHYSICS 54

SYLLABUS : DUAL NATURE OF MATTER & RADIATION (Matter Waves, Photon, Photoelectric effect, X-ray)

Max. Marks : 120 **Time : 60 min.**

GENERAL INSTRUCTIONS

- The Daily Practice Problem Sheet contains 30 MCQ's. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.
- You have to evaluate your Response Grids yourself with the help of solution booklet.
- Each correct answer will get you 4 marks and 1 mark shall be deduced for each incorrect answer. No mark will be given/ deducted if no bubble is filled. Keep a timer in front of you and stop immediately at the end of 60 min.
- The sheet follows a particular syllabus. Do not attempt the sheet before you have completed your preparation for that syllabus. Refer syllabus sheet in the starting of the book for the syllabus of all the DPP sheets.
- After completing the sheet check your answers with the solution booklet and complete the Result Grid. Finally spend time to analyse your performance and revise the areas which emerge out as weak in your evaluation.

DIRECTIONS (Q.1-Q.21) : There are 21 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d), out of which **ONLY ONE** choice is correct.

Q.1 Energy of a α-particle, having de broglie wavelength of 0.004 Å is approximately.

(a) 1275 eV (b) 1200 KeV

(c) 1200 MeV (d) 1200 GeV

Q.2 Velocity of a proton is c/20. Associated de-Broglie wavelength is (Take $h = 6.626 \times 10^{-34}$ J–s)

(a) 2.64×10^{-24} mm (b) 2.64×10^{-24} cm

(c) 2.64×10^{-14} Å (d) 2.64×10^{-14} m

Q.3 One electron & one proton is accelerated by equal potential. Ratio of their de-Broglie wavelengths is-

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

Q.4 de-Broglie wavelength of an electron is 10 Å then velocity will be-

(a) 7.2×10^7 m/s (b) 7.2×10^6 m/s

(c) 7.2×10^5 m/s (d) 7.2×10^4 m/s

Q.5 One electron & one proton have equal energies then ratio of associated de-Broglie wavelength will be-

(a) $1 : (1836)^2$ (b) $\sqrt{1836} : 1$

(c) 1836 : 1 (d) $(1836)^2 : 1$

RESPONSE GRID	1. ⓐⓑⓒⓓ	2. ⓐⓑⓒⓓ	3. ⓐⓑⓒⓓ	4. ⓐⓑⓒⓓ	5. ⓐⓑⓒⓓ

Space for Rough Work

Q.6 The ratio of wavelength of deutron & proton accelerated by an equal potential is

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

(c) $\frac{1}{2}$ (d) $\frac{2}{1}$

Q.7 In photoelectric effect if intensity of light is doubled then maximum kinetic energy of photoelectrons will become

(a) Double (b) Half

(c) Four time (d) No change

Q.8 Quantum nature of light is explained by which of the following phenomenon?

(a) Huygen wave theory

(b) Photoelectric effect

(c) Maxwell electromagnetic theory

(d) de- Broglie theory

Q.9 From rest an electron is accelerated between two such points which has potential 20 & 40 volts respectively. Associated de-Broglie wavelength of electron is-

(a) 0.75 Å (b) 7.5 Å

(c) 2.75 Å (d) 2.75 m

Q.10 An electron microscope uses 40 keV electrons. Find its resolving limit on the assumption that it is equal to the wavelength of the electron-

(a) 0.61 Å (b) 0.6 Å

(c) 0.06 Å (d) 0.061 Å

Q.11 A hydrogen atom moving at a speed v absorbs a photon of wavelength 122 nm and stops. Find the value of v. (Mass of hydrogen atom = 1.67×10^{-27} kg)

(a) 3.5 m/s (b) 32.5 m/s

(c) 3.05 m/s (d) 3.25 m/s

Q.12 The de-Broglie wavelength of an electron is 0.2 Å. Calculate the potential difference (approximate) required to retard it to rest-

(a) 3.76×10^{-3} V (b) 3.76×10^{3} V

(c) 3.76×10^{3} eV (d) 376.5 V

Q.13 A photon and an electron have equal energy E. $\lambda_{photon}/\lambda_{electron}$ is proportional to

(a) $\sqrt{E}$ (b) $\frac{1}{\sqrt{E}}$

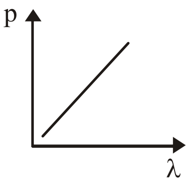
(c) $\frac{1}{E}$ (d) Does not depend upon E.

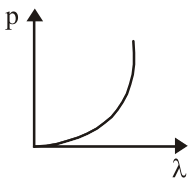
Q.14 In a photoemissive cell with exciting wavelength λ, the fastest electron has speed v. If the exciting wavelength is changed to $3\lambda/4$, the speed of the fastest emitted electron will be

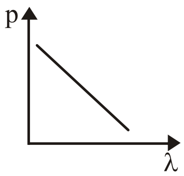
(a) $v\,(3/4)^{1/2}$ (b) $v\,(4/3)^{1/2}$

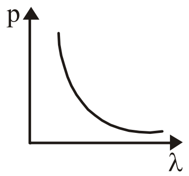
(c) Less than $v\,(4/3)^{1/2}$ (d) Greater than $v\,(4/3)^{1/2}$

Q.15 Which of the following figure repesents variation of particle momentum and the associated de-Broglie wavelength?

(a)


(b)


(c)


(d)


Q.16 The work function for the surface of aluminium is 4.2 eV. What will be the wavelength of that incident light for which the stopping potential will be zero.

($h \approx 6.6 \times 10^{-34}$ J–s $e \approx 1.6 \times 10^{-19}$ C)

(a) 2496 Å (b) 2946×10^{-7} m

(c) 2649 Å (d) 2946 Å

RESPONSE GRID					
	6. ⓐⓑⓒⓓ	7. ⓐⓑⓒⓓ	8. ⓐⓑⓒⓓ	9. ⓐⓑⓒⓓ	10. ⓐⓑⓒⓓ
	11. ⓐⓑⓒⓓ	12. ⓐⓑⓒⓓ	13. ⓐⓑⓒⓓ	14. ⓐⓑⓒⓓ	15. ⓐⓑⓒⓓ
	16. ⓐⓑⓒⓓ				

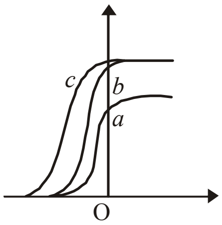
Space for Rough Work

Q.17 Slope of $V_0 - \nu$ curve is-
(where V_0 = Stopping potential and ν = frequency)
(a) e (b) $\frac{h}{e}$ (c) ϕ_0 (d) h

Q.18 A radio station is transmitting waves of wavelength 300 m. If diffracting power of transmitter is 10 kW, then numbers of photons diffracted per second is-
(a) 1.5×10^{35} (b) 1.5×10^{31}
(c) 1.5×10^{29} (d) 1.5×10^{33}

Q.19 Light of wavelength 3320 Å is incident on metal surface (work function = 1.07 eV). To stop emission of photo electron, retarding potential required to be
(Take $hc \approx 12420$ eV – Å)
(a) 3.74 V (b) 2.67 V (c) 1.07 V (d) 4.81 V

Q.20 The figure shows the variation of photocurrent with anode potential for a photo-sensitive surface for three different radiations. Let I_a, I_b and I_c be the intensities and f_a, f_b and f_c be the frequencies for the curves a, b and c respectively. Then



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

Q.21 An electromagnetic radiation of frequency 3×10^{15} cycles per second falls on a photo electric surface whose work function is 4.0 eV. Find out the maximum velocity of the photo electrons emitted by the surface-
(a) 13.4×10^{-19} m/s (b) 19.8×10^{-19}m/s
(c) 1.73×10^{6} m/s (d) None

DIRECTIONS (Q.22-Q.24) : In the following questions, more than one of the answers given are correct. Select the correct answers and mark it according to the following codes:

Codes :
(a) 1, 2 and 3 are correct **(b)** 1 and 2 are correct
(c) 2 and 4 are correct **(d)** 1 and 3 are correct

Q.22 Ultraviolet light of wavelength 280 nm is used in an experiment on photo electric effect with lithium (ϕ = 2.5 eV) cathode.
(1) The maximum kinetic energy is 1 .9 eV
(2) The stopping potential is1.9 V
(3) The maximum kinetic energy is 4.4 V
(4) The stopping potential is 4.4 eV

Q.23 The separation between Bragg's planes in a crystal is 10 Å. Then the wavelength of those X-rays which can be diffracted by this crystal is-
(1) 5 Å (2) 10 Å
(3) 20 Å (4) 25 Å

Q.24 Electrons are accelerated in television tubes through potential difference of about 10 KV.
(1) The lowest wavelength of the emitted X-rays is 12.4Å
(2) The lowest wavelength of the emitted X-rays is 1.24Å
(3) The highest frequency of the emitted X-rays is 2.4×10^{8} Hz
(4) The highest frequency of the emitted X-rays is 2.4×10^{18} Hz

DIRECTIONS (Q.25-Q.27) : Read the passage given below and answer the questions that follows :

A physicist wishes to eject electrons by shining light on a metal surface. The light source emits light of wavelength of 450 nm. The table lists the only available metals and their work functions.

Metal	W_0 (eV)
Barium	2.5
Lithium	2.3
Tantalum	4.2
Tungsten	4.5

Q.25 Which metal(s) can be used to produce electrons by the photoelectric effect from given source of light ?
(a) Barium only
(b) Barium or lithium
(c) Lithium, tantalum or tungsten
(d) Tungsten or tantalum

RESPONSE GRID					
	17. ⓐⓑⓒⓓ	18. ⓐⓑⓒⓓ	19. ⓐⓑⓒⓓ	20. ⓐⓑⓒⓓ	21. ⓐⓑⓒⓓ
	22. ⓐⓑⓒⓓ	23. ⓐⓑⓒⓓ	24. ⓐⓑⓒⓓ	25. ⓐⓑⓒⓓ	

Space for Rough Work

Q.26 Which option correctly identifies the metal that will produce the most energetic electrons and their energies ?
(a) Lithium, 0.45 eV (b) Tungsten, 1.75 eV
(c) Lithium, 2.30 eV (d) Tungsten, 2.75 eV

Q.27 Suppose photoelectric experiment is done separately with these metals with light of wavelength 450 nm. The maximum magnitude of stopping potential amongst all the metals is-
(a) 2.75 volt (b) 4.5 volt
(c) 0.45 volt (d) 0.25 volt

DIRECTIONS (Q. 28-Q.30) : Each of these questions contains two statements: Statement-1 (Assertion) and Statement-2 (Reason). Each of these questions has four alternative choices, only one of which is the correct answer. You have to select the correct choice.

(a) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(b) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(c) Statement -1 is False, Statement-2 is True.
(d) Statement -1 is True, Statement-2 is False.

Q.28 Statement -1 : Mass of moving photon varies directly as the wavelength.
Statement -2 : Energy of the particle = Mass × (Speed of light)^2

Q.29 Statement -1 : Photosensitivity of a metal is large if its work function is small.
Statement -2 : Work function = hf_0 where f_0 is the threshold frequency.

Q.30 Statement -1 : The de-Broglie wavelength of a molecule varies inversely as the square root of temperature.
Statement -2 : The root mean square velocity of the molecule is proportional to square root of absolute temperature.

RESPONSE GRID					
	26. ⓐⓑⓒⓓ	27. ⓐⓑⓒⓓ	28. ⓐⓑⓒⓓ	29. ⓐⓑⓒⓓ	30. ⓐⓑⓒⓓ

DAILY PRACTICE PROBLEM SHEET 54 - PHYSICS			
Total Questions	30	Total Marks	120
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	30	Qualifying Score	50
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

Space for Rough Work

DAILY PRACTICE PROBLEMS

PHYSICS SOLUTIONS 54

1. (a). $\lambda_\alpha = \frac{0.101}{\sqrt{V}}$ Å, $\sqrt{V} = \frac{0.101}{0.004}$

$\sqrt{V} = 25.25\,V, V = 637.5\,V$

$E_\alpha = q_\alpha \times V_\alpha \approx 1275\,eV$

2. (d). $\lambda = \frac{h}{mv}$

$\because\ v = \frac{c}{20} = \frac{3\times10^8}{20} = 1.5 \times 10^7$ m/sec

$h = 6.626 \times 10^{-34}$ J-s, $m = 1.67 \times 10^{-27}$ kg

$\therefore\ \lambda = \frac{6.626\times10^{-34}}{1.67\times10^{-27}\times1.5\times10^7}$

$\Rightarrow \lambda = 2.64 \times 10^{-14}$ m

3. (a). $\because \lambda \propto \frac{1}{\sqrt{m}} \Rightarrow \lambda_e \propto \frac{1}{\sqrt{m_e}}, \lambda_p \propto \frac{1}{\sqrt{m_p}}$

$\therefore\ \frac{\lambda_e}{\lambda_p} = \sqrt{\frac{m_p}{m_e}}$

4. (c). $\lambda = \frac{h}{mv} \Rightarrow v = \frac{h}{m\lambda}$,

$v = \frac{6.6\times10^{-34}}{9.1\times10^{-31}\times10\times10^{-10}} = 7.2 \times 10^5$ m/s

5. (b). $\lambda \propto \frac{1}{\sqrt{m}}$,

$\frac{\lambda_e}{\lambda_p} = \sqrt{\frac{m_p}{m_e}} = \sqrt{\frac{1836}{1}}$

6. (a). $\lambda_p = \frac{h}{\sqrt{2m_p e_p V}}$

$\Rightarrow \lambda_d = \frac{h}{\sqrt{2m_d e_d V}}$

$\therefore\ \frac{\lambda_d}{\lambda_p} = \sqrt{\frac{m_p e_p}{m_d e_d}}$ $\quad \because\ m_d = 2m_p$,

$e_d = e_p \Rightarrow \frac{\lambda_d}{\lambda_p} = \sqrt{\frac{m_p e_p}{2m_p e_p}} = \frac{1}{\sqrt{2}}$

7. (d). K_{max} of photoelectrons doesn't depends upon intensity of incident light.

8. (b).

$$\lambda = \frac{6.62\times10^{-34}}{\sqrt{2\times9.1\times10^{-31}\times13.6\times1.6\times10^{-19}}}$$

$\Rightarrow \lambda = 3.3 \times 10^{-10}$ m = 3.3 Å

9. (c). $\lambda = \frac{12.27}{\sqrt{V}}$ Å

$\Rightarrow V = 40–20 = 20$ Volt

$\Rightarrow \lambda = \frac{12.27}{\sqrt{20}}$ Å = 2.75 Å

10. (d). Wavelength of electrons is $\lambda = \sqrt{\frac{150}{V}}$ Å

Now, electrons have energy of 40 KeV, therefore they are accelerated through a potential difference of 40×10^3 volt.

$\lambda = \sqrt{\frac{150}{40\times10^3}} = 0.061$ Å

$\therefore$ Resolving limit of electron microscope = 0.061 Å

11. (d). The linear momentum of the photon

$= \frac{h}{\lambda} = \frac{6.63\times10^{-34}}{122\times10^{-9}} = 5.43 \times 10^{-27}\ \frac{kg-m}{s}$

$\because\ p = mv \Rightarrow v = \frac{p}{m}$

$\Rightarrow v = \frac{5.43\times10^{-27}}{1.67\times10^{-27}} = 3.25$ m/s

12. (b). $V = \frac{150}{\lambda_e^2}$ volt, to determine the p.d. through which it was accelerated to achieve the given de-broglie wavelength. Then the same p.d. will retard it to rest. Thus,

$V = \frac{150}{0.2\times0.2}$ volt, $V = 3765$ Volt $= 3.76$ kV

13. (b). $\lambda_{photon} = \frac{hc}{E}$ and $\lambda_{proton} = \frac{h}{\sqrt{2me}}$

$\Rightarrow \frac{\lambda_{photon}}{\lambda_{electron}} = c\sqrt{\frac{2m}{E}} \Rightarrow \frac{\lambda_{photon}}{\lambda_{electron}} \propto \frac{1}{\sqrt{E}}$

14. **(d).** $hv - W_0 = \frac{1}{2}mv_{max}^2 \Rightarrow \frac{hc}{\lambda} - \frac{hc}{\lambda_0} = \frac{1}{2}mv_{max}^2$

$$\Rightarrow hc\left(\frac{\lambda_0 - \lambda}{\lambda\lambda_0}\right) = \frac{1}{2}mv_{max}^2 \Rightarrow v_{max} = \sqrt{\frac{2hv}{m}\left(\frac{\lambda_0 - \lambda}{\lambda\lambda_0}\right)}$$

When wavelength is λ and velocity is v, then

$$v = \sqrt{\frac{2hv}{m}\left(\frac{\lambda_0 - \lambda}{\lambda\lambda_0}\right)} \quad ....(i)$$

When wavelength is $\frac{3\lambda}{4}$ and velocity is 'v' then

$$v' = \sqrt{\frac{2hc}{m}\left[\frac{\lambda_0 - (3\lambda/4)}{(3\lambda/4)\times\lambda_0}\right]} \quad ...(ii)$$

Divide equation (ii) by (i), we get

$$\frac{v'}{v} = \sqrt{\frac{[\lambda_0 - (3\lambda/4)]}{\frac{3}{4}\lambda\lambda_0} \times \frac{\lambda\lambda_0}{\lambda_0 - \lambda}}$$

$$v' = v\left(\frac{4}{3}\right)^{1/2}\sqrt{\frac{[\lambda_0 - (3\lambda - 4)]}{\lambda_0\lambda}}$$

i.e $\quad v' > v\left(\frac{4}{3}\right)^{1/2}$

15. **(d).** De-Broglie wavelength $\lambda = \frac{h}{p}$

$$\Rightarrow \quad \lambda \propto \frac{1}{p}$$

i.e. graph will be a rectangular hyperbola.

16. **(d).** If the incident light be of threshold wavelength (λ_0), then the stopping potential shall be zero. Thus

$$\lambda_0 = \frac{hc}{\phi}, \quad \lambda_0 = \frac{6.6\times10^{-34}\times3\times10^8}{4.2\times1.6\times10^{-19}}$$

$\lambda_0 = 2.946 \times 10^{-7}$ m $= 2946$ Å

17. **(b).** Relation between $V_0 - \nu$., $V_0 = \frac{h\nu}{e} - \frac{h\nu_0}{e}$

Put it in the form of $y = mx - c$,

here $V_0 = y$, $\nu = x$, $\frac{h\nu_0}{e} = c$

$$\therefore y = \left(\frac{h}{e}\right)x - c$$

$$\therefore m = \frac{h}{e}$$

18. **(b).** $P = 10 \times 10^3$ watt, $n = ?$, $\lambda = 300$ m

$$P = \frac{nhc}{\lambda t}$$

$$10^4 = \frac{6.62\times10^{-34}\times3\times10^8\times n}{300\times1}$$

$$n = \frac{300\times10^4}{6.62\times10^{-34}\times3\times10^8} = 1.5\times10^{31}$$

19. **(b).** $V_0 = \frac{hc}{e\lambda} - \frac{\phi_0}{e} = 3.74 - 1.07 = 2.67$ V

20. **(a).** The stopping potential for curves a and b is same.

$\therefore \quad f_a = f_b$

Also saturation current is proportional to intensity

$\therefore \quad I_a < I_b$

21. **(c).** $h\nu = h\nu_0 + E_k$

$6.6\times10^{-34}\times3\times10^{15} = 4\times1.6\times10^{-19} + E_k$

$19.8\times10^{-19} - 6.4\times10^{-19} = E_k$

$E_k = 13.4\times10^{-19}$ J

$$\Rightarrow \frac{1}{2}mv_{max}^2 = 13.4\times10^{-19}$$

$$v_{max} = \sqrt{\frac{2\times13.4\times10^{-19}}{m}}$$

$$= \sqrt{\frac{2\times13.4\times10^{-19}}{9\times10^{-31}}} = 1.73\times10^6 \text{ m/s}$$

22. **(b).** The maximum kinetic energy is

$$K_{max} = \frac{hc}{\lambda} - \phi = \frac{1242 \text{ eV}-\text{nm}}{280 \quad \text{nm}} - 2.5 \text{ eV}$$

$= 4.4$ eV $- 2.5$ eV $= 1.9$ eV

Stopping potential V is given by $eV = K_{max}$

$$V = \frac{K_{max}}{e} = \frac{1.9}{e}\text{eV} = 1.9 \text{ V}$$

23. **(a).** $\because 2d\sin\phi = n\lambda$

$$\lambda_{max} = \frac{(2d\sin\phi)_{max}}{n_{min}} = \frac{2d\sin 90^\circ}{1} = 2\times10 \text{ Å}$$

$\lambda_{max} = 20$Å

$\therefore$ Possible wavelengths are 5Å, 10Å and 20Å.

24. **(c).** $\lambda_{min} = \frac{12400}{10000}$ Å $= 1.24$ Å

$$v_{max} = \frac{c}{\lambda_{min}} = \frac{3\times10^8}{1.24\times10^{-10}} = 2.4\times10^{18} \text{ Hz.}$$

25. **(b)** $\Delta E = \frac{12400}{4500\text{Å}}$

$\Delta = 2.75$ eV

For photoelectric effect, $\Delta E > W_0$ (work function).

26. **(a)** $\Delta E = W_0 + E$; $(E_k) = \Delta E - W_0$

For maximum value of (E_k), W_0 should be minimum

W_0 for lithium = 2.3 eV

$\therefore$ $(E_k) = 2.75 - 2.3 = 0.45$ eV

27. **(c)** The maximum magnitude of stopping potential will be for metal of least work function.

$\therefore$ required stopping potential is

$$V_s = \frac{hv - \phi_0}{e} = 0.45 \text{ volt.}$$

28. **(c)** Mass of moving photon $m = \frac{hv}{c^2} = \frac{h}{c\lambda}$ and $E = mc^2$

29. **(c)** Less work function means less energy is required for ejecting out the electrons.

30. **(a)** de-Broglie wavelength associated with gas molecules varies as $\lambda \propto \frac{1}{\sqrt{T}}$