

# PHYSICS

## Dual Nature of Radiation and Matter

No. of Questions  
**45**

Maximum Marks  
**180**

Time  
**1 Hour**

*Speed*  
**TEST**  
**25**

Chapter-wise

### GENERAL INSTRUCTIONS

- This test contains 45 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 solutions provided at the end of this book.
- Each correct answer will get you 4 marks and 1 mark shall be deducted 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.
- 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.

- A particle of mass 1 mg has the same wavelength as an electron moving with a velocity of  $3 \times 10^6 \text{ ms}^{-1}$ . The velocity of the particle is:
  - $2.7 \times 10^{-18} \text{ ms}^{-1}$
  - $9 \times 10^{-2} \text{ ms}^{-1}$
  - $3 \times 10^{-31} \text{ ms}^{-1}$
  - $2.7 \times 10^{-21} \text{ ms}^{-1}$
- An electron of mass  $m$  and a photon have same energy  $E$ . The ratio of de-Broglie wavelengths associated with them is:
  - $\frac{1}{c} \left( \frac{E}{2m} \right)^{\frac{1}{2}}$
  - $\left( \frac{E}{2m} \right)^{\frac{1}{2}}$
  - $c(2mE)^{\frac{1}{2}}$
  - $\frac{1}{c} \left( \frac{2m}{E} \right)^{\frac{1}{2}}$
- All electrons ejected from a surface by incident light of wavelength 200nm can be stopped before travelling 1m in the direction of uniform electric field of 4N/C. The work function of the surface is
  - 4 eV
  - 6.2 eV
  - 2 eV
  - 2.2 eV
- The maximum kinetic energy of the electrons hitting a target so as to produce X-ray of wavelength 1 Å is
  - 1.24 keV
  - 12.4 keV
  - 124 keV
  - None of these
- An X-ray tube is operated at 15 kV. Calculate the upper limit of the speed of the electrons striking the target.
  - $7.26 \times 10^7 \text{ m/s}$
  - $7.62 \times 10^9 \text{ m/s}$
  - $7.62 \times 10^7 \text{ cm/s}$
  - $7.26 \times 10^9 \text{ m/s}$
- A and B are two metals with threshold frequencies  $1.8 \times 10^{14} \text{ Hz}$  and  $2.2 \times 10^{14} \text{ Hz}$ . Two identical photons of energy 0.825 eV each are incident on them. Then photoelectrons are emitted in (Take  $h = 6.6 \times 10^{-34} \text{ Js}$ )
  - B alone
  - A alone
  - neither A nor B
  - both A and B.
- If  $E_1, E_2, E_3$  are the respective kinetic energies of an electron, an alpha-particle and a proton, each having the same de-Broglie wavelength, then
  - $E_1 > E_3 > E_2$
  - $E_2 > E_3 > E_1$
  - $E_1 > E_2 > E_3$
  - $E_1 = E_2 = E_3$

### RESPONSE GRID

1. (a) (b) (c) (d)

2. (a) (b) (c) (d)

3. (a) (b) (c) (d)

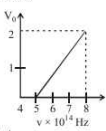
4. (a) (b) (c) (d)

5. (a) (b) (c) (d)

6. (a) (b) (c) (d)

7. (a) (b) (c) (d)

Space for Rough Work

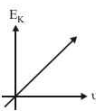
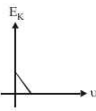
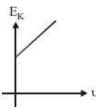
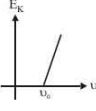
8. Which of the following when falls on a metal will emit photoelectrons ?  
 (a) UV radiations (b) Infrared radiation  
 (c) Radio waves (d) Microwaves
9. The stopping potential ( $V_0$ ) versus frequency ( $\nu$ ) plot of a substance is shown in figure, the threshold wavelength is  
 (a)  $5 \times 10^{14}$  m  
 (b) 6000 Å  
 (c) 5000 Å  
 (d) Cannot be estimated from given data
- 
10. A material particle with a rest mass  $m_0$  is moving with speed of light  $c$ . The de-Broglie wavelength associated is given by  
 (a)  $\frac{h}{m_0 c}$  (b)  $\frac{m_0 c}{h}$  (c) zero (d)  $\infty$
11. A 200 W sodium street lamp emits yellow light of wavelength 0.6  $\mu$ m. Assuming it to be 25% efficient in converting electrical energy to light, the number of photons of yellow light it emits per second is  
 (a)  $1.5 \times 10^{20}$  (b)  $6 \times 10^{18}$   
 (c)  $62 \times 10^{20}$  (d)  $3 \times 10^{19}$
12. A proton has kinetic energy  $E = 100$  keV which is equal to that of a photon. The wavelength of photon is  $\lambda_2$  and that of proton is  $\lambda_1$ . The ratio of  $\lambda_2/\lambda_1$  is proportional to  
 (a)  $E^2$  (b)  $E^{1/2}$  (c)  $E^{-1}$  (d)  $E^{-1/2}$
13. In photoelectric effect the work function of a metal is 3.5 eV. The emitted electrons can be stopped by applying a potential of -1.2 V. Then  
 (a) the energy of the incident photon is 4.7 eV  
 (b) the energy of the incident photon is 2.3 eV  
 (c) if higher frequency photon be used, the photoelectric current will rise  
 (d) when the energy of photon is 3.5 eV, the photoelectric current will be maximum
14. 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 5 V. The incident radiation lies in  
 (a) ultra-violet region (b) infra-red region  
 (c) visible region (d) X-ray region
15. When photons of energy  $h\nu$  fall on an aluminium plate (of work function  $E_0$ ), 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  
 (a)  $2K$  (b)  $K$  (c)  $K + h\nu$  (d)  $K + E_0$
16. Which metal will be suitable for a photoelectric cell using light of wavelength 4000 Å. The work functions of sodium and copper are respectively 2.0 eV and 4.0 eV.  
 (a) Sodium (b) Copper  
 (c) Both (d) None of these
17. The maximum velocity of an electron emitted by light of wavelength  $\lambda$  incident on the surface of a metal of work-function  $\phi$  is  
 (a)  $\sqrt{\frac{2(hc + \lambda\phi)}{m\lambda}}$  (b)  $\frac{2(hc + \lambda\phi)}{m\lambda}$   
 (c)  $\sqrt{\frac{2(hc - \lambda\phi)}{m\lambda}}$  (d)  $\sqrt{\frac{2(h\lambda - \phi)}{m}}$
18. If the kinetic energy of a free electron doubles, its deBroglie wavelength changes by the factor  
 (a) 2 (b)  $\frac{1}{2}$  (c)  $\sqrt{2}$  (d)  $\frac{1}{\sqrt{2}}$
19. Radiations of two photon's energy, twice and ten times the work function of metal are incident on the metal surface successively. The ratio of maximum velocities of photoelectrons emitted in two cases is  
 (a) 1 : 2 (b) 1 : 3 (c) 1 : 4 (d) 1 : 1
20. The cathode of a photoelectric cell is changed such that the work function changes from  $W_1$  to  $W_2$  ( $W_2 > W_1$ ). If the current before and after changes are  $I_1$  and  $I_2$ , all other conditions remaining unchanged, then (assuming  $h\nu > W_2$ )  
 (a)  $I_1 = I_2$  (b)  $I_1 < I_2$   
 (c)  $I_1 > I_2$  (d)  $I_1 < I_2 < 2I_1$
21. Monochromatic radiation emitted when electron on hydrogen atom jumps from first excited to the ground state irradiates a photosensitive material. The stopping potential is measured to be 3.57 V. The threshold frequency of the materials is :  
 (a)  $4 \times 10^{15}$  Hz (b)  $5 \times 10^{15}$  Hz  
 (c)  $1.6 \times 10^{15}$  Hz (d)  $2.5 \times 10^{15}$  Hz
22. Photoelectric work function of a metal is 1 eV. Light of wavelength  $\lambda = 3000$  Å falls on it. The photo electrons come out with velocity  
 (a) 10 metres/sec (b)  $10^2$  metres/sec  
 (c)  $10^4$  metres/sec (d)  $10^6$  metres/sec
23. When the energy of the incident radiation is increased by 20%, the kinetic energy of the photoelectrons emitted from a metal surface increased from 0.5 eV to 0.8 eV. The work function of the metal is :  
 (a) 0.65 eV (b) 1.0 eV (c) 1.3 eV (d) 1.5 eV
24. The maximum distance between interatomic lattice planes is 15 Å. The maximum wavelength of X-rays which are diffracted by this crystal will be  
 (a) 15 Å (b) 20 Å (c) 30 Å (d) 45 Å

RESPONSE  
GRID

8. (a)(b)(c)(d) 9. (a)(b)(c)(d)  
 13. (a)(b)(c)(d) 14. (a)(b)(c)(d)  
 18. (a)(b)(c)(d) 19. (a)(b)(c)(d)  
 23. (a)(b)(c)(d) 24. (a)(b)(c)(d)

10. (a)(b)(c)(d) 11. (a)(b)(c)(d)  
 15. (a)(b)(c)(d) 16. (a)(b)(c)(d)  
 20. (a)(b)(c)(d) 21. (a)(b)(c)(d)

12. (a)(b)(c)(d) 17. (a)(b)(c)(d)  
 22. (a)(b)(c)(d)

25. In photoelectric effect, stopping potential for a light of frequency  $n_1$  is  $V_1$ . If light is replaced by another having a frequency  $n_2$  then its stopping potential will be
- (a)  $V_1 - \frac{h}{e}(n_2 - n_1)$  (b)  $V_1 + \frac{h}{e}(n_2 + n_1)$   
 (c)  $V_1 + \frac{h}{e}(n_2 - 2n_1)$  (d)  $V_1 + \frac{h}{e}(n_2 - n_1)$
26. The maximum kinetic energy of the photoelectrons ejected from a photocathode when it is irradiated with light of wavelength 440 nm is 1 eV. If the threshold energy of the surface is 1.9 eV, then which of the following statement is/are incorrect?
- (a) The threshold frequency for photo sensitive metal is  $4.6 \times 10^{14}$  Hz  
 (b) The minimum wavelength of incident light required for photoemission is 6513 Å.  
 (c) The maximum wavelength of incident light required for photoemission is 6513 Å.  
 (d) The energy of incident photon is 2.9 eV.
27. The work functions of metals A and B are in the ratio 1 : 2. If light of frequencies  $f$  and  $2f$  are incident on the surfaces of A and B respectively, the ratio of the maximum kinetic energies of photoelectrons emitted is ( $f$  is greater than threshold frequency of A,  $2f$  is greater than threshold frequency of B)
- (a) 1 : 1 (b) 1 : 2 (c) 1 : 3 (d) 1 : 4
28. Which one of the following graphs represents the variation of maximum kinetic energy ( $E_K$ ) of the emitted electrons with frequency  $\nu$  in photoelectric effect correctly?
- (a)  (b)   
 (c)  (d) 
29. The potential difference that must be applied to stop the fastest photoelectrons emitted by a nickel surface, having work function 5.01 eV, when ultraviolet light of 200 nm falls on it, must be:
- (a) 2.4 V (b) -1.2 V (c) -2.4 V (d) 1.2 V
30. X-rays are produced in X-ray tube operating at a given accelerating voltage. The wavelength of the continuous X-rays has values from
- (a) 0 to  $\infty$   
 (b)  $\lambda_{\min}$  to  $\infty$ , where  $\lambda_{\min} > 0$   
 (c) 0 to  $\lambda_{\max}$ , where  $\lambda_{\max} < \infty$   
 (d)  $\lambda_{\min}$  to  $\lambda_{\max}$ , where  $0 < \lambda_{\min} < \lambda_{\max} < \infty$
31. 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
- (a) increase by 2 times (b) decrease by 2 times  
 (c) decrease by 4 times (d) increase by 4 times
32. In the Davisson and Germer experiment, the velocity of electrons emitted from the electron gun can be increased by
- (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 filament
33. 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:
- (a) 1 : 4 (b) 1 : 2 (c) 1 : 1 (d) 1 : 5
34. Photoelectric emission is observed from a metallic surface for frequencies  $\nu_1$  and  $\nu_2$  of the incident light rays ( $\nu_1 > \nu_2$ ). If the maximum values of kinetic energy of the photoelectrons emitted in the two cases are in the ratio of 1 : k, then the threshold frequency of the metallic surface is
- (a)  $\frac{\nu_1 - \nu_2}{k - 1}$  (b)  $\frac{k\nu_1 - \nu_2}{k - 1}$   
 (c)  $\frac{k\nu_2 - \nu_1}{k - 1}$  (d)  $\frac{\nu_2 - \nu_1}{k}$
35. Which of the following is/are false regarding cathode rays?
- (a) They produce heating effect  
 (b) They don't deflect in electric field  
 (c) They cast shadow  
 (d) They produce fluorescence
36. The ratio of the respective de Broglie wavelengths associated with electrons accelerated from rest with the voltages 100 V, 200 V and 300 V is
- (a) 1 : 2 : 3 (b) 1 : 4 : 9 (c)  $1 : \frac{1}{\sqrt{2}} : \frac{1}{\sqrt{3}}$  (d)  $1 : \frac{1}{2} : \frac{1}{3}$

RESPONSE  
GRID

25. (a) (b) (c) (d)

30. (a) (b) (c) (d)

35. (a) (b) (c) (d)

26. (a) (b) (c) (d)

31. (a) (b) (c) (d)

36. (a) (b) (c) (d)

27. (a) (b) (c) (d)

32. (a) (b) (c) (d)

28. (a) (b) (c) (d)

33. (a) (b) (c) (d)

29. (a) (b) (c) (d)

34. (a) (b) (c) (d)

37. A 5 watt source emits monochromatic light of wavelength 5000 Å. When placed 0.5 m away, it liberates photoelectrons from a photosensitive metallic surface. When the source is moved to a distance of 1.0 m, the number of photoelectrons liberated will be reduced by a factor of  
(a) 8 (b) 16 (c) 2 (d) 4
38. In the photoelectric effect, electrons are emitted  
(a) at a rate that is proportional to the amplitude of the incident radiation  
(b) with a maximum velocity proportional to the frequency of the incident radiation  
(c) at a rate that is independent of the emitter  
(d) only if the frequency of the incident radiations is above a certain threshold value
39. The threshold frequency for a photosensitive metal is  $3.3 \times 10^{14}$  Hz. If light of frequency  $8.2 \times 10^{14}$  Hz is incident on this metal, the cut-off voltage for the photoelectric emission is nearly  
(a) 2 V (b) 3 V (c) 5 V (d) 1 V
40. In an experiment on photoelectric effect, a student plots stopping potential  $V_0$  against reciprocal of the wavelength  $\lambda$  of the incident light for two different metals A and B. These are shown in the figure.
- 
- Looking at the graphs, you can most appropriately say that:  
(a) Work function of metal B is greater than that of metal A  
(b) For light of certain wavelength falling on both metal, maximum kinetic energy of electrons emitted from A will be greater than those emitted from B.
- (c) Work function of metal A is greater than that of metal B  
(d) Students data is not correct
41. White X-rays are called white due to the fact that  
(a) they are electromagnetic radiations having nature same as that of white light.  
(b) they are produced most abundantly in X ray tubes.  
(c) they have a continuous wavelength range.  
(d) they can be converted to visible light using coated screens and photographic plates are affected by them just like light.
42. The wavelength associated with an electron, accelerated through a potential difference of 100 V, is of the order of  
(a) 1000 Å (b) 100 Å (c) 10.5 Å (d) 1.2 Å
43. Monochromatic light of frequency  $6.0 \times 10^{14}$  Hz is produced by a laser. The power emitted is  $2 \times 10^{-3}$  W. The number of photons emitted, on the average, by the sources per second is  
(a)  $5 \times 10^{16}$  (b)  $5 \times 10^{17}$  (c)  $5 \times 10^{14}$  (d)  $5 \times 10^{15}$
44. The de-Broglie wavelength of neutron in thermal equilibrium at temperature T is  
(a)  $\frac{30.8}{\sqrt{T}}$  Å (b)  $\frac{3.08}{\sqrt{T}}$  Å (c)  $\frac{0.308}{\sqrt{T}}$  Å (d)  $\frac{0.0308}{\sqrt{T}}$  Å
45. Which of the following cannot be explained on the basis of photoelectric theory?  
(a) Instantaneous emission of photoelectrons  
(b) Existence of threshold frequency  
(c) Sufficiently intense beam of radiation can emit photoelectrons  
(d) Existence of stopping potential

RESPONSE  
GRID

37. (a)(b)(c)(d)

38. (a)(b)(c)(d)

39. (a)(b)(c)(d)

40. (a)(b)(c)(d)

41. (a)(b)(c)(d)

42. (a)(b)(c)(d)

43. (a)(b)(c)(d)

44. (a)(b)(c)(d)

45. (a)(b)(c)(d)

### PHYSICS CHAPTERWISE SPEED TEST-25

Total Questions	45	Total Marks	180
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	45	Qualifying Score	60
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct $\times$ 4) – (Incorrect $\times$ 1)			

Space for Rough Work