1. The idea of matter waves was given by
(a) Davisson and Germer (b) de-Broglie
(c) Einstein (d) Planck

2. Wave is associated with matter
(a) When it is stationary
(b) When it is in motion with the velocity of light only
(c) When it is in motion with any velocity
(d) None of the above

3. The de-Broglie wavelength associated with the particle of mass *m* moving with velocity *v* is
(a) h/mv (b) mv/h
(c) mh/v (d) m/hv

4. A photon, an electron and a uranium nucleus all have the same wavelength. The one with the most energy
(a) Is the photon
(b) Is the electron
(c) Is the uranium nucleus
(d) Depends upon the wavelength and the properties of the particle.

5. A particle which has zero rest mass and non-zero energy and momentum must travel with a speed
(a) Equal to *c*, the speed of light in vacuum
(b) Greater than *c*
(c) Less than *c*
(d) Tending to infinity

6. When the kinetic energy of an electron is increased, the wavelength of the associated wave will
(a) Increase
(b) Decrease
(c) Wavelength does not depend on the kinetic energy
(d) None of the above

7. If the de-Broglie wavelengths for a proton and for a $\alpha-$particle are equal, then the ratio of their velocities will be
(a) 4 : 1 (b) 2 : 1
(c) 1 : 2 (d) 1 : 4

8. The de-Broglie wavelength λ associated with an electron having kinetic energy *E* is given by the expression
(a) $\frac{h}{\sqrt{2mE}}$ (b) $\frac{2h}{mE}$
(c) $2mhE$ (d) $\frac{2\sqrt{2mE}}{h}$

9. Dual nature of radiation is shown by
(a) Diffraction and reflection
(b) Refraction and diffraction
(c) Photoelectric effect alone

(d) Photoelectric effect and diffraction

10. For the Bohr's first orbit of circumference $2\pi r$, the de-Broglie wavelength of revolving electron will be

(a) $2\pi r$ (b) πr

(c) $\frac{1}{2\pi r}$ (d) $\frac{1}{4\pi r}$

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

(a) $\lambda\frac{m}{M}$ (b) $\lambda\sqrt{\frac{m}{M}}$

(c) $\lambda\frac{M}{m}$ (d) $\lambda\sqrt{\frac{M}{m}}$

12. What will be the ratio of de-Broglie wavelengths of proton and $\alpha-$particle of same energy

(a) 2 : 1 (b) 1 : 2

(c) 4 : 1 (d) 1 : 4

13. What is the de-Broglie wavelength of the $\alpha-$particle accelerated through a potential difference V

(a) $\frac{0.287}{\sqrt{V}}$ Å (b) $\frac{12.27}{\sqrt{V}}$ Å

(c) $\frac{0.101}{\sqrt{V}}$ Å (d) $\frac{0.202}{\sqrt{V}}$ Å

14. de-Broglie hypothesis treated electrons as

(a) Particles (b) Waves

(c) Both '*a*' and '*b*' (d) None of these

15. The energy that should be added to an electron, to reduce its de-Broglie wavelengths from 10^{-10} m to 0.5×10^{-10} m, will be

(a) Four times the initial energy

(b) Thrice the initial energy

(c) Equal to the initial energy

(d) Twice the initial energy

16. The de-Broglie wavelength of an electron having $80\,eV$ of energy is nearly

($1eV = 1.6 \times 10^{-19}\ J$, Mass of electron $= 9 \times 10^{-31} kg$

Plank's constant $= 6.6 \times 10^{-34}$ *J-sec*)

(a) 140 Å (b) 0.14 Å

(c) 14 Å (d) 1.4 Å

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

(a) Neutron (b) Proton

(c) β-particle (d) α -particle

18. If an electron and a photon propagate in the form of waves having the same wavelength, it implies that they have the same

(a) Energy (b) Momentum
(c) Velocity (d) Angular momentum

19. The de-Broglie wavelength is proportional to

(a) $\lambda \propto \frac{1}{v}$ (b) $\lambda \propto \frac{1}{m}$
(c) $\lambda \propto \frac{1}{p}$ (d) $\lambda \propto p$

20. Particle nature and wave nature of electromagnetic waves and electrons can be shown by

(a) Electron has small mass, deflected by the metal sheet
(b) X-ray is diffracted, reflected by thick metal sheet
(c) Light is refracted and defracted
(d) Photoelectricity and electron microscopy

21. The de-Broglie wavelength of a particle moving with a velocity 2.25×10^8 *m/s* is equal to the wavelength of photon. The ratio of kinetic energy of the particle to the energy of the photon is (velocity of light is 3×10^8 *m/s*)

(a) 1/8 (b) 3/8
(c) 5/8 (d) 7/8

22. According to de-Broglie, the de-Broglie wavelength for electron in an orbit of hydrogen atom is 10^{-9} *m*. The principle quantum number for this electron is

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

23. The speed of an electron having a wavelength of $10^{-10} m$ is

(a) 7.25×10^6 *m/s* (b) $6.26 \times 10^6 m/s$
(c) $5.25 \times 10^6 m/s$ (d) $4.24 \times 10^6 m/s$

24. The kinetic energy of electron and proton is $10^{-32} J$. Then the relation between their de-Broglie wavelengths is

(a) $\lambda_p < \lambda_e$ (b) $\lambda_p > \lambda_e$
(c) $\lambda_p = \lambda_e$ (d) $\lambda_p = 2\lambda_e$

25. The de-Broglie wavelength of a particle accelerated with 150 *volt* potential is 10^{-10} *m*. If it is accelerated by 600 *volts* p.d., its wavelength will be

(a) 0.25 *Å* (b) 0.5 *Å*
(c) 1.5 *Å* (d) 2 *Å*

26. The de-Broglie wavelength associated with a hydrogen molecule moving with a thermal velocity of 3 *km/s* will be

(a) 1 *Å* (b) 0.66 *Å*
(c) 6.6 *Å* (d) 66 *Å*

27. When the momentum of a proton is changed by an amount P_0, the corresponding change in the de-Broglie wavelength is found to be 0.25%. Then, the original momentum of the proton was

(a) p_0 (b) 100 p_0
(c) 400 p_0 (d) 4 p_0

28. The de-Broglie wavelength of a neutron at 27°C is λ. What will be its wavelength at 927°C

(a) $\lambda / 2$ (b) $\lambda / 3$
(c) $\lambda / 4$ (d) $\lambda / 9$

29. An electron and proton have the same de-Broglie wavelength. Then the kinetic energy of the electron is

(a) Zero
(b) Infinity
(c) Equal to the kinetic energy of the proton
(d) Greater than the kinetic energy of the proton

30. For moving ball of cricket, the correct statement about de-Broglie wavelength is

(a) It is not applicable for such big particle
(b) $\frac{h}{\sqrt{2mE}}$
(c) $\sqrt{\frac{h}{2mE}}$
(d) $\frac{h}{2mE}$

1. (b)

2. (c) According to de-Broglie hypothesis.

3. (a) $\lambda = \frac{h}{p} = \frac{h}{mv}$

4. (a) $\lambda = \frac{h}{mv} = \frac{h}{\sqrt{2mE}}$: $\therefore E = \frac{h^2}{2m\lambda^2}$

λ is same for all, so $E \propto \frac{1}{m}$. Hence energy will be maximum for particle with lesser mass.

5. (a) Particle is photon and it travels with the velocity equal to light in vacuum.

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

7. (a) $\lambda = \frac{h}{m_1 v_1} = \frac{h}{m_2 v_2}$; $\therefore \frac{v_1}{v_2} = \frac{m_2}{m_1} = \frac{4}{1}$

8. (a) $\frac{1}{2}mv^2 = E \Rightarrow mv = \sqrt{2mE}$; $\therefore \lambda = \frac{h}{mv} = \frac{h}{\sqrt{2mE}}$

9. (d) $\left.\begin{array}{l}\text{Photoelectric effect} \rightarrow \text{Particle nature} \\ \text{Diffraction} \rightarrow \text{Wave nature}\end{array}\right\}\text{Dual nature}$

10. (a) $mvr = \frac{nh}{2\pi}$ According to Bohr's theory

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

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

12. (a) $\lambda = \frac{h}{\sqrt{2mE}} \Rightarrow \lambda \propto \frac{1}{\sqrt{m}} \Rightarrow \frac{\lambda_p}{\lambda_\alpha} = \sqrt{\frac{m_\alpha}{m_p}} = \frac{2}{1}$

13. (c) $\lambda = \frac{h}{\sqrt{2mE}} = \frac{h}{\sqrt{2m_\alpha Q_\alpha V}}$

On putting $Q_\alpha = 2 \times 1.6 \times 10^{-19}\,C$

$m_\alpha = 4m_p = 4 \times 1.67 \times 10^{-27}\,kg \Rightarrow \lambda = \frac{0.101}{\sqrt{V}}\,Å$

14. (b)

15. (b) $\lambda = \frac{h}{\sqrt{2mE}} \Rightarrow \lambda \propto \frac{1}{\sqrt{E}} \Rightarrow \frac{\lambda_1}{\lambda_2} = \sqrt{\frac{E_2}{E_1}}$

$\Rightarrow \frac{10^{-10}}{0.5 \times 10^{-10}} = \sqrt{\frac{E_2}{E_1}} \Rightarrow E_2 = 4E_1$

Hence added energy $= E_2 - E_1 = 3E_1$

16. (d) $\lambda = \frac{h}{\sqrt{2mE}} = \frac{6.6 \times 10^{-34}}{\sqrt{2 \times 9 \times 10^{-31} \times 80 \times 1.6 \times 10^{-19}}} = 1.4 Å$

17. (c) $\lambda = \frac{h}{mv} \Rightarrow \lambda \propto \frac{1}{m}$

18. (b) If an electron and a photon propagates in the from of waves having the same wavelength, it implies that they have same momentum. This is according to de-Broglie equation, $p \propto \frac{1}{\lambda}$

19. (c) $\lambda = \frac{h}{p} \Rightarrow \lambda \propto \frac{1}{p}$

20. (d) In photoelectric effect particle nature of electron is shown. While in electron microscope, beam of electron is considered as electron wave.

21. (b) $K_{\text{particle}} = \frac{1}{2}mv^2$ also $\lambda = \frac{h}{mv}$

$$\Rightarrow K_{\text{particle}} = \frac{1}{2}\left(\frac{h}{\lambda v}\right).v^2 = \frac{vh}{2\lambda} \quad ...(i)$$

$$K_{\text{photon}} = \frac{hc}{\lambda} \quad ...(ii)$$

$$\therefore \frac{K_{\text{particle}}}{K_{\text{photon}}} = \frac{v}{2c} = \frac{2.25 \times 10^8}{2 \times 3 \times 10^8} = \frac{3}{8}$$

22. (c) $2\pi r n = \lambda \Rightarrow n = \frac{\lambda}{2\pi r} = \frac{10^{-9}}{2 \times 3.14 \times 5.13 \times 10^{-11}} = 3$

23. (a) By using $\lambda_{electron} = \frac{h}{m_e v} \Rightarrow v = \frac{h}{m_e \lambda_e} = \frac{6.6 \times 10^{-34}}{9.1 \times 10^{-31} \times 10^{-10}} = 7.25 \times 10^6 m/s.$

24. (a) By using $\lambda = \frac{h}{\sqrt{2mE}}$ $E = 10^{-32} J$ = Constant for both particles. Hence $\lambda \propto \frac{1}{\sqrt{m}}$ Since $m_p > m_e$ so $\lambda_p < \lambda_e$.

25. (b) By using $\lambda \propto \frac{1}{\sqrt{V}} \Rightarrow \frac{\lambda_1}{\lambda_2} = \sqrt{\frac{V_2}{V_1}} \Rightarrow \frac{10^{-10}}{\lambda_2} = \sqrt{\frac{600}{150}} = 2 \Rightarrow \lambda_2 = 0.5 Å.$

26. (b) $\lambda = \frac{h}{mv_{rms}} \Rightarrow \lambda = \frac{6.6 \times 10^{-34}}{2 \times 1.67 \times 10^{-27} \times 3 \times 10^3} = 0.66 Å$

27. (c) $\lambda \propto \frac{1}{p} \Rightarrow \frac{\Delta p}{p} = -\frac{\Delta\lambda}{\lambda} \Rightarrow \left|\frac{\Delta p}{p}\right| = \left|\frac{\Delta\lambda}{\lambda}\right|$

$$\Rightarrow \frac{p_0}{p} = \frac{0.25}{100} = \frac{1}{400} \Rightarrow p = 400\, p_0.$$

28. (a) $\lambda_{neutron} \propto \frac{1}{\sqrt{T}} \Rightarrow \frac{\lambda_1}{\lambda_2} = \sqrt{\frac{T_2}{T_1}}$

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

29. (d) $\lambda = \frac{h}{\sqrt{2mE}} \Rightarrow E \propto \frac{1}{\sqrt{m}}$ ($\lambda =$ constant)

$\because m_e < m_p$ so $E_e > E_p$

30. (b)