JEE MAIN ANSWER KEY & SOLUTIONS

SUBJECT :- PHYSICS

CLASS :- 12th **PAPER CODE :- CWT-9**

CHAPTER :- MODERN PHYSICS

ANSWER KEY

1.	(D)	**2.**	(A)	**3.**	(A)	**4.**	(D)	**5.**	(C)	**6.**	(B)	**7.**	(A)
8.	(B)	**9.**	(A)	**10.**	(D)	**11.**	(D)	**12.**	(A)	**13.**	(A)	**14.**	(B)
15.	(D)	**16.**	(D)	**17.**	(B)	**18.**	(C)	**19.**	(A)	**20.**	(C)	**21.**	1
22.	55	**23.**	2	**24.**	112	**25.**	26	**26.**	0.4	**27.**	2	**28.**	3
29.	8	**30.**	1.73										

SOLUTIONS

1. (D)

2. (A)

Sol. Shortest wavelength of Bracket series corresponds to the transition of electron $n_1 = 4$ and $n_2 = \infty$ and the shortest wavelength of Belmar series corresponds to the transition of electron between $n_1 = 2$ and $n_2 = \infty$. So

$(Z^2)\left(\frac{13.6}{16}\right) = \left(\frac{13.6}{4}\right)$

$\therefore$ $Z^2 = 4$ or $Z = 2$

3. (A)

Sol. $evB = \frac{mv^2}{R} \Rightarrow v = \frac{e}{m}BR$

K.E. of photoelectrons

$K = \frac{1}{2}mv^2 = \frac{e^2B^2R^2}{2m} = 2.97 \times 10^{-15}$ J

K.E. = 2.97×10^{-15} J = 18.6 KeV

K.E. = $E_P - E(K)$

$E(K) = E_P -$ K.E. = 24.8 – 18.6 = 6.2 K.E.

4. (D)

Sol. Power P of fission reactor.

$P = 10^6$ watt $= 10^6$ joule/sec

Time = t = 1 day = $24 \times 36 \times 10^2$ sec

Energy produced, U = Pt

or $U = 10^6 \times 24 \times 36 \times 10^2$

$= 24 \times 36 \times 10^8$ joule

Energy released per fission of U^{235}

200 MeV = 32×10^{-12} J

Number of U^{235} atoms used

$= \frac{24 \times 36 \times 10^8}{32 \times 10^{-12}} = 27 \times 10^{20}$

Mass of 6×10^{23} atoms of U^{235} = 235 g

Mass of 27×10^{20} atoms of U^{235}

$= \left(\frac{235}{6 \times 10^{23}}\right)(27 \times 10^{20})$

= 1.058 g $\simeq$ 1 g

5. (C)

Sol. $\frac{1}{2}mv^2_{max} = h\nu - h\nu_o = h(\nu - \nu_o)$

This is Einstein's equation of photoelectric effect.

6. (B)

Sol. $\frac{hc}{e}\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right) = \upsilon$

7. (A)

Sol. According to Einstein's photoelectric equation $h\upsilon = KE_{max} + \phi_0$

8. (B)

Sol. Stopping potential is the energy required to stop the moving electrons after photoelectric emission. Hence it must be equal to the kinetic energy of the emitted electron.

Incident energy = Threshold energy + Kinetic energy

$\Rightarrow h\nu = h\nu_0 + eV_0$ and $h\frac{v}{2} = h\nu_o + \frac{eV_o}{4}$

Solving the equations gives:

$\nu_o = \frac{v}{3}$

9. (A)

Sol. Energy of a photon, $E = h\upsilon$ ......(i)

Also, E = pc ......(ii)

Where p is the momentum of a photon.

From (i) and (ii), we get

$h\upsilon = pc$ or $p = \frac{h\upsilon}{c}$

10. (D)

11. (D)

Sol. According to Einstein's quantum theory light propagates in the form of packets i.e. quanta of energy, which is called photon. The rest mass of photons is being zero. It can be shown, according to the relativity theory of light.

According to the relativistic theory equation, the mass of the photon is computed as:

$m = \frac{m_o}{\sqrt{1 - \frac{v^2}{c^2}}}$, $m_0 = m\sqrt{1 - \frac{v^2}{c^2}}$

when v=0; So $m_0 = 0$

Where m_0 is the rest mass of the Photon.

12. (A)

Sol. Energy of photon, E = 3MeV
= 3×10^{6}eV

Linear momentum of the photon, p = $\frac{E}{c}$

where c is the speed of light in vacuum

$$p=\frac{3\times10^{6}\,ev}{3\times10^{8}\,ms^{-1}}=10^{-2}\,eVsm^{-1}=0.01\,eVsm^{-1}$$

13. (A)

Sol. We have

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

$$\Rightarrow v=\frac{h}{m\lambda}=\frac{6.63\times10^{-34}}{9.1\times10^{-31}\times10^{-10}}=7.25\times10^{6}\,m/s$$

14. (B)

Sol. $K_{particle}=\frac{1}{2}mv^{2}\,also\,\lambda=\frac{h}{mv}$

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

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

$$\therefore \frac{K_{particle}}{K_{photon}}=\frac{v}{2c}=\frac{2.25\times10^{8}}{2\times3\times10^{8}}=\frac{3}{8}$$

15. (D)

Sol. $E=\frac{hc}{\lambda},p=\frac{h}{\lambda}$

On decreasing wavelength, momentum and energy will increase.

16. (D)

Sol. Intensity $I\propto\frac{1}{r^{2}}$

Where r is the distance.

17. (B)

Sol. $K_{1_{max}}$ $h\nu_1-\phi$ = 1 – 0.5 = 0.5 eV

$K_{2_{max}}$ = 2.5 – 0.5 = 2.0 eV

Thus $K_{1_{max}}$: $K_{2_{max}}$ = 0.5 : 2 = 1 : 4

18. (C)

Sol. $\frac{I_0}{I}$ = 4, x = 7 mm (given)

$$\Rightarrow \mu=\frac{23.03\log_{10}\frac{I_0}{I}}{x}$$

m = 0.198 mm^{-1}

19. (A)

Sol. $V_{rms}=\sqrt{\frac{3KT}{m}}$

$$\lambda=\frac{h}{\sqrt{3KTm}}$$

$$=\frac{6.63\times10^{-34}}{\sqrt{3\times4.64\times10^{-26}\times1.38\times10^{-23}\times400}}$$

$$=0.24\,\text{Å}$$

20. (C)

Sol. $E=\frac{hc}{\lambda}=\frac{6.63\times10^{-34}\times3\times10^{8}}{5896\times10^{-10}}J$

= 3.37×10^{-19} J = 2.1 eV

21. 1

Sol. Here A_0 = 8 counts, A = 1 count and t = 3h.

$$\frac{A}{A_0}=\left(\frac{1}{2}\right)^{n}, \quad \Rightarrow\frac{1}{8}=\left(\frac{1}{2}\right)^{n}$$

or $\Rightarrow\left(\frac{1}{2}\right)^{3}=\left(\frac{1}{2}\right)^{n}\Rightarrow n=3$

So, $T_{1/2}=\frac{t}{n}=\frac{3}{3}=1h$

22. 55

Sol. Excitation energy in first excited state = $13.6z^2\left(\frac{1}{1^2}-\frac{1}{2^2}\right)$

$40.8 = 13.6z^2\left(\frac{3}{4}\right)$

$z^2=\left(\frac{40.8\times4}{13.6\times3}\right)$

Now, energy needed to remove electron from ground state.

$E' = 13.6\,z^2\left(\frac{1}{1^2}-\frac{1}{\infty^2}\right)$

$=13.6\times\left(\frac{40.8\times4}{13.6\times3}\right)$

= 54.4 eV

23. 2

Sol. ${}^{230}_{90}Th\rightarrow{}^{214}_{84}PO+4{}^{4}_{2}He+2\beta$

$$\alpha=\frac{230-214}{4}=4$$

90 = 84 + 2α – y

90 – 84 –2 × 4 = –y

β = 2

ratio of α and β

$\Rightarrow\frac{4}{2}=\frac{2}{1}$ or $\frac{n_\alpha}{n_\beta}=\frac{4}{2}=2$

24. 112

Sol. $N \propto \dfrac{1}{\sin^4(\theta/2)}$

$\dfrac{28}{N} = \dfrac{\sin^4(60°/2)}{\sin^4(90°/2)} = \dfrac{1}{4}$

$\dfrac{28}{N} = \dfrac{(1/2)^4}{(1/\sqrt{2})^4}$

$\Rightarrow \dfrac{28}{N} = \dfrac{1/16}{1/4}$

$\Rightarrow \dfrac{28}{N} = \dfrac{4}{16}$

$\Rightarrow$ N = 28 × 4

N = 112

25. 26

Sol. energy released = Binding energy of product B. E of reactants

= 7.6 × 4 – (1.1 × 2) × 2 = 26 MeV

26. 0.4

Sol. $2k = \left(\dfrac{kq^2}{r}\right)$

where k – kinetic energy of each deutron.

$2k = \dfrac{9\times10^9 \times (1.6\times10^{-19})^2}{2\times10^{-15}}$

$2k = \dfrac{9\times1.6\times10^{-10}}{2\times10^{-15}} ev$

$k = \dfrac{1.44\times10^5}{4} ev$

k = 0.36 MeV

27. 2

Sol. From the law of conservation of motion, we know that.

$m_1v_1 = m_2v_2$

i.e., $\dfrac{v_1}{v_2} = \dfrac{m_2}{m_1}$

$\Rightarrow \dfrac{v_1}{v_2} = \dfrac{r_2^3}{r_1^3} = \left(\dfrac{r_2}{r_1}\right)^3$

$\dfrac{v_1}{v_2} = \left(\dfrac{2^{\frac{1}{3}}}{1}\right)^3 = \dfrac{2}{1}$

Now, on comparing the above value with the given ratio (n : 1), we get,

n = 2

28. 3

Sol. For I[st] excitation potential at of He

$n_i = 1 \quad n_f = 2 \quad z = 2$

$\Delta E = E_f - E_i = -13.6(z)^2 \left(\dfrac{1}{n_f^2} - \dfrac{1}{n_i^2}\right) = 40.8eV$

So excitation potential = 40.8 volt

For the ionisation of Li^{++}

$n_i = 1 \quad n_f = \infty \quad z = 3$

$\Delta E = E_f - E_i = -13.6(z)^2 \left(\dfrac{1}{n_f^2} - \dfrac{1}{n_i^2}\right) = \dfrac{+13.6z^2}{n_i^2}$

$= \dfrac{13.6(3)^2}{(1)^2} = 1.224 \times 10^2$ eV

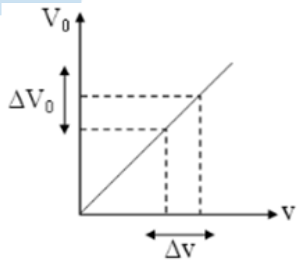
So excitation potential = 1.224×10^2 Volt

$\dfrac{122.4}{40.8} = 3$

29. 8

Sol: $V_0 = \left(\dfrac{h}{e}\right)v - \left(\dfrac{h}{e}\right)v_0$

$\text{Slop } m = \dfrac{h}{e} = \dfrac{\Delta V_0}{\Delta v}$



$\Delta v = \dfrac{e}{h} \times \Delta V_p$

$\dfrac{1.6\times10^{-19}}{6\times10^{-34}} \times 30 = 8\times10^{15} s^{-1}$

30. 1.73

Sol. For an electron, de-Broglie wavelength is given by,

$\lambda = \sqrt{\dfrac{150}{V}} = \sqrt{\dfrac{150}{50}}$

$= \sqrt{3} = 1.73$ Å