(1) **(B).** The de-broglie wavelength is $2\pi r_2 = 2\lambda$
$\lambda = \pi r_2$
$r_2 = 2^2 r_1 = 4r_1 = 4 \times 0.53 = 2.12$ Å
$\lambda = 3.14 \times 2.12 = 6.66$ Å

(2) **(C).** The energy of 10 eV means that
E = eV = 10 e Volt ; V = 10 Volt
The electron was accelerated through a p.d. of 10 V.

$$\lambda = \frac{12.27}{\sqrt{V}} \text{ Å} = \frac{12.27}{\sqrt{10}} \text{ Å} = 3.9 \text{ Å}$$

(3) **(C).** Since $W_0 = \frac{hc}{\lambda_0} \therefore \frac{(W_0)_T}{(W_0)_{Na}} = \frac{\lambda_{Na}}{\lambda_T}$

or $\lambda_T = \frac{\lambda_{Na} \times (W_0)_{Na}}{(W_0)_T}$

$$= \frac{5460 \times 2.3}{4.5} = 2791 \text{ Å}$$

(4) **(B).** $W_0 = \frac{12375}{\lambda_0(\text{Å})} = \frac{12375}{5420} = 2.28 \text{ eV}$

(5) **(D).** $W_0 = h\nu_0$

$$\Rightarrow \nu_0 = \frac{W_0}{h} = \frac{2.51 \times 1.6 \times 10^{-19}}{6.6 \times 10^{-34}}$$

$$= 6.08 \times 10^{14} \text{ Cycle / sec.}$$

(6) **(C).** $W.(eV) = \frac{12375}{\lambda_0(\text{Å})}$

$$\Rightarrow \lambda_0 = \frac{12375}{4.125} = 3000 \text{Å}$$

(7) **(C).** $P = \frac{W}{t} = \frac{nhc}{\lambda t}$

$$\Rightarrow 10^3 = \frac{n \times 6.6 \times 10^{-34} \times 3 \times 10^8}{198.6 \times 1}$$

$$\Rightarrow n = 10^{30}$$

(8) **(C).** $E = \frac{hc}{\lambda} \Rightarrow \frac{E_1}{E_2} = \frac{\lambda_2}{\lambda_1}$

$$\Rightarrow \frac{3.32 \times 10^{-19}}{E_2} = \frac{4000}{6000}$$

$$\Rightarrow E_2 = 4.98 \times 10^{-19} \text{J} = 3.1 \text{eV}.$$

(9) **(A).** Slope of graph is h/e = constant

(10) **(A).** $\frac{\lambda_{m_2}}{\lambda_{m_1}} = \frac{V_1}{V_2} \Rightarrow \lambda_{m_2} = \frac{6.22 \times 10^3}{10^4}$

$$= 0.622 \text{ Å}$$

(11) **(D).** $\frac{E_1}{E_2} = \frac{hc}{\lambda_1}\frac{\lambda_2}{hc} = \frac{\lambda_2}{\lambda_1} \Rightarrow \frac{E_1}{E_2} = \frac{50}{1}$

(12) **(A).** Covalent bond is due to wave nature.

(13) **(C).** $\lambda = \frac{h}{\sqrt{2mE}}$

(14) **(A).** $W_0 = h\nu_0 = \frac{hc}{\lambda_0}$

$$\frac{(\lambda_0)K}{(\lambda_0)Na} = \frac{(W_0)Na}{(W_0)K} = \frac{2.3}{4.5} = \frac{1}{2}$$

(15) **(A).** $\lambda = \frac{hc}{W_0} = \frac{12420 \times 10^{-10}}{W_0 (eV)}$

$$= \frac{12420 \times 10^{-10}}{4eV} = 310 \text{nm}$$

(16) **(B).** Intensity $\propto \frac{1}{\text{distance}^2}$
Distance is halved intensity becomes four times, so emitted electron becomes four times.

(17) **(B).** $(K.E.)_1 = h\nu_1 - h\nu_0$
$(K.E.)_2 = h\nu_2 - h\nu_0$
As $(K.E.)_1 = 2 \times (K.E.)_2$
$(h\nu_1 - h\nu_0) = 2(h\nu_2 - h\nu_0)$
or $\nu_0 = 2\nu_2 - \nu_1$
$= 2 \times (2.0 \times 10^{16}) - (3.2 \times 10^{16})$
$= 0.8 \times 10^{16}$ Hz or 8×10^{15} Hz

(18) **(B).** $W = \frac{hc}{\lambda} - K_{max}$

$$= \frac{1240}{400} - 1.68 = 1.42 \text{eV}$$

(19) **(C).** Power of the bulb = 100 watt = 100 J s^{-1}
Energy of one photon $E = h\nu = hc/\lambda$

$$= \frac{6.626\times10^{-34}\,Js\times3\times10^{8}\,m/s}{400\times10^{-9}\,m}$$

$= 4.969 \times 10^{-19}$ J
Number of photons emitted per second is

$$\frac{n}{t} = \frac{P}{E} = \frac{100\ Js^{-1}}{4.969\times10^{-19}\,J}$$

$= 2.012 \times 10^{20}\ s^{-1}$

(20) **(A).** Work function, $\phi_0 = h\,\nu_0$
where ν_0 is the threshold frequency
So, $\phi_0 \propto \nu_0$. Hence Pt > Al > K

(21) **(D).** When a beam of electrons of energy E_0 is incident on a metal surface kept in an evacuated chamber, electrons can be emitted with maximum energy E_0 (due to elastic collision) and with any energy less than E_0, when part of incident energy of electron is used in liberating the electrons from the surface of metal.

(22) **(A).** Consider an electron of mass m and charge e accelerated from rest through potential V.

Then $K = eV$; $K = \frac{1}{2}mv^2 = \frac{p^2}{2m}$

$\therefore \quad p = \sqrt{2mK} = \sqrt{2meV}$

The de Broglie wavelength λ of the electron

is $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mK}} = \frac{h}{\sqrt{2meV}}$

Substituting the numerical values of h, m, e, we get

$$\lambda = \frac{6.63\times10^{-34}}{\sqrt{2\times9.1\times10^{-31}\times1.6\times10^{-19}\times V}}$$

$$= \frac{1.227\times10^{-9}}{\sqrt{V}}\,m = \frac{1.227}{\sqrt{V}}\,nm$$

(23) **(D).** Photoelectric current depends on
(i) the intensity of incident light.
(ii) the potential difference applied between the two electrodes.
(iii) the nature of the emitter material.

(24) **(A).**
(i) The graph shows that the stopping potential V_0 varies linearly with the frequency of incident radiation for a given photosensitive material.
(ii) There exists a certain minimum cut- off frequency ν_0 for which the stopping potential is zero.
(iii) The maximum kinetic energy of the photoelectrons varies linearly with the frequency of incident radiation, but is independent on intensity.

(25) **(B).** Here, E = 1 MeV = 10^6 eV,
$h = 6.63 \times 10^{-34}$ J s, $c = 3 \times 10^8$ m s^{-1}

$$hc = \frac{6.63\times10^{-34}\times3\times10^{8}}{1.6\times10^{-19}} \approx 1240\,eV\,nm$$

As $E = \frac{hc}{\lambda}$ or $\lambda = \frac{hc}{E} = \frac{1240\ eV\ nm}{10^6\,eV}$

$= 1.24 \times 10^{-3}$ nm

(26) **(D).** $E_{photon} = \frac{12400}{3000} = 4.13$ eV
Photoelectric effect can take place only if $E_{photon} \geq \phi$
Thus, Li, Na, K, Mg can show photoelectric effect.

(27) **(B).** The maximum kinetic energy of the emitted electron is given by
$K_{max} = h\nu - \phi_0 = h\,(4\nu) - h\,(\nu) = 3\,h\nu$

(28) **(D).** $\frac{hc}{\lambda} - \phi = eV$; $V = \frac{hc}{e\lambda} - \frac{\phi}{e}$

For plate 1 : $\frac{\phi_1}{hc} = 0.001$

For plate 2 : $\frac{\phi_2}{hc} = 0.002$

For plate 3 : $\frac{\phi_3}{hc} = 0.004$

$\phi_1 : \phi_2 : \phi_3 = 1:2:4$

For plate 2, threshold wavelength

$$\lambda = \frac{hc}{\phi_2} = \frac{hc}{0.002\ hc} = \frac{1000}{2} = 500nm$$

For plate 3, threshold wavelength

$$\lambda = \frac{hc}{\phi_3} = \frac{hc}{0.004\ hc} = \frac{1000}{4} = 250nm$$

Since violet colour light λ is 400 nm, so

$\lambda_{violet} < \lambda_{threshold}$ for plate 2

So, violet colour light will eject photoelectrons from plate 2 and not from plate 3.

(29) **(A).** $E_{\lambda_1}(550nm) = \frac{1240}{550} eV = 2.25eV$

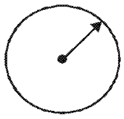
$$E_{\lambda_2}(450nm) = \frac{1240}{450} eV = 2.8eV$$

$$E_{\lambda_3}(350nm) = \frac{1240}{350} eV = 3.5eV$$

For metal r, only λ_3 is able to generate photoelectron.

For metal q, only λ_2 and λ_3 are able to generate photoelectron. For metal p, all wavelength are able to generate photoelectron. Hence photoelectric current will be maximum for p and least for r.

(30) **(D).** $\frac{hc}{\lambda} = \phi + eV$



$$\frac{1240\ (eV)\ (nm)}{200\ (nm)} = 4.7\ (eV) + eV$$

$$\frac{1240}{200} e = 4.7e + eV$$

$6.2 - 4.7 = V \qquad \therefore\ V = 1.5$ volt

$$\frac{1}{4\pi\varepsilon_0}\frac{Q}{R} = 1.5\ ; \quad (9\times10^9)\frac{Ne}{\frac{1}{100}} = 1.5$$

9×10^{11} Ne = 1.5

$$N = \frac{1.5}{9\times10^{11}\times1.6\times10^{-19}} = \frac{15}{16}\times\frac{1}{9}\times10^8$$

$$= \frac{5}{3\times16}\times10^8 = \frac{50}{48}\times10^7$$

$\therefore$ Z = 7

(31) **(C).** $E = \frac{hc}{\lambda}$

$$\Rightarrow E = \frac{12375}{\lambda\ (\text{in Å})} eV \Rightarrow E = \frac{12375}{4100} eV$$

$\Rightarrow E \approx 3eV$

(32) **(C).** $h\nu - \phi = K_{max} = \frac{1}{2} mv_{max}^2$

According to question,

$$\frac{5h\nu_0 - h\nu_0}{2h\nu_0 - h\nu_0} = \frac{v_2^2}{v_1^2}$$

$v_2 = 2v_1 = 2 \times 4 \times 10^6 = 8 \times 10^6$ m/s

(33) **(A).** A photo-cell employs photoelectric effect to convert light energy into photoelectric current.

(34) **(A).** When electrons emitted from cathode collide with gas molecules atoms, they knock out outer electrons and produce positively charged ions. They become part of positive ray.

(35) **(C).** 1MeV = $10^6 \times 1.6 \times 10^{-19}$ joule

$$\text{Momentum of photon} = \frac{E}{c} = \frac{1.6\times10^{-13}}{3\times10^8}$$

$$= \frac{1.6}{3}\times10^{-21} = \frac{16}{3}\times10^{-22}$$

$= 5 \times 10^{-22}$ kg m/sec.

(36) **(D).** Since $p = \frac{nh\nu}{t}$

$$\Rightarrow \frac{n}{t} = \frac{p}{h\nu} = \frac{2\times10^{-3}}{6.6\times10^{-34}\times6\times10^{14}}$$

$= 5 \times 10^{15}$

(37) **(D).** Number of emitted electrons

$$N_E \propto \text{Intensity} \propto \frac{1}{(\text{Distance})^2}$$

Therefore, as distance is doubled,

N_E decreases by (1/4) times.

(38) **(A).** $KE_{max} = h\nu - \phi$

or $h\nu = KE_{max} + \phi = 5\ eV + 6.2\ eV$

$= 11.2$ eV

$$\lambda = \frac{12420 \times 10^{-10}}{11.2\,(eV)}$$

$\cong 1000$ Å which is in ultraviolet region.

(39) **(B).** $m_e v_e = mv$

$$v = \frac{m_e v_e}{m} = \frac{9.1 \times 10^{-31} \times 3 \times 10^{6}}{10^{-6}}$$

$= 2.7 \times 10^{-18}$ m/s

(40) **(B).** Saturation current $\propto$ intensity

(41) **(A).** Curves (a) & (b) represent incident radiations of same frequency but of different intensities.

(42) **(A).** $\lambda = 667 \times 10^{-9}$m, $P = 9 \times 10^{-3}$W

$P = \frac{Nhc}{\lambda}$, N : No. of photons emitted/sec.

$$N = \frac{9 \times 10^{-3} \times 667 \times 10^{-9}}{6.6 \times 10^{-34} \times 3 \times 10^{8}}$$

$$= \frac{9 \times 6.67 \times 10^{-10}}{3 \times 6.6 \times 10^{-26}} \simeq 3 \times 10^{16} \text{ /sec}$$

(43) (D), (44) (D).

$$\phi_A = \frac{13.6}{4} eV,\ \phi_B = \frac{13.6 \times 4}{4} eV$$

$$E - \phi_A = (KE)_A,\ E - \phi_B = (KE)_B$$

$$KE_A = 2KE_B;\quad E - \phi_A = 2(E - \phi_B)$$

$$E = 2\phi_B - \phi_A = 2 \times 13.6 - \frac{13.6}{4} = 23.8 eV$$

(45) **(D).** Einstein P.E. equation

Case I : $eV = \frac{hc}{\lambda} - \frac{hc}{\lambda_0}$ .... (1)

Case II :

$e\frac{V}{4} = \frac{hc}{2\lambda} - \frac{hc}{\lambda_0} \Rightarrow eV = \frac{4hc}{2\lambda} - \frac{4hc}{\lambda_0}$ .... (2)

Eq. (1) – eq. (2)

$$\frac{hc}{\lambda} - \frac{2hc}{\lambda} = -\frac{4hc}{2\lambda} + \frac{hc}{\lambda_0} \Rightarrow \frac{hc}{\lambda} = -\frac{3hc}{\lambda_0} \Rightarrow \lambda_0 = 3\lambda$$