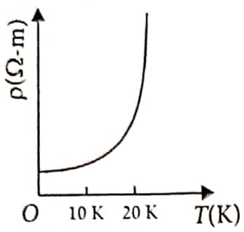
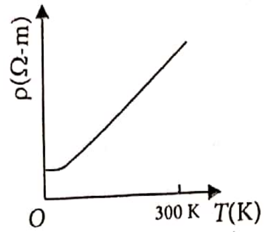
SOLUTIONS

1. (i) The resistivity of a conductor increases non-linearly with increase in temperature.

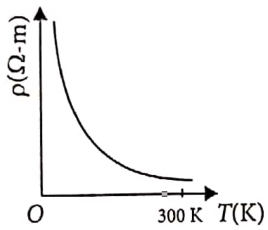


(For low temperature)



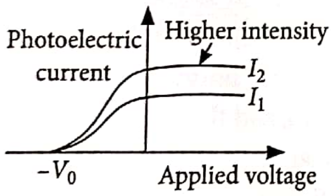
(For high temperature)

(ii) The resistivity of a semiconductor decreases with increase in temperature.



2. (a) (i) Threshold Frequency : The minimum frequency of incident light which is just capable of ejecting electrons from a metal is called the threshold frequency. It is denoted by υ_0.
(ii) Stopping Potential : The minimum retarding potential applied to anode of a photoelectric tube which is just capable of stopping photoelectric current is called the stopping potential. It is denoted by V_0 (or V_S).

(b)



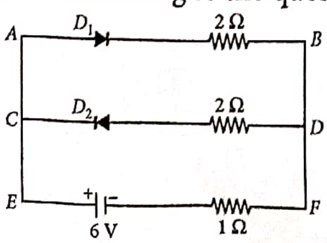
OR

Here, $\lambda = 390$ nm

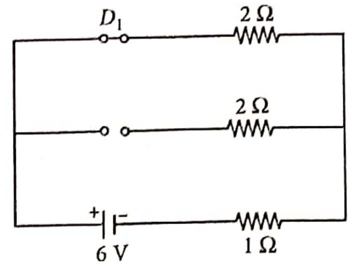
Energy of a photon, $E = \dfrac{hc}{\lambda}$

$$\therefore \quad E = \frac{1240 \text{ eV nm}}{390 \text{ nm}} = 3.2 \text{ eV}$$

3. According to the question



D_2 will be reversed biased and D_1 will be forward biased so equivalent circuit will be



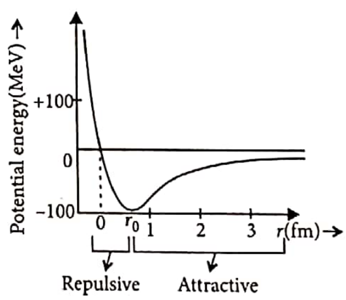
So current in 1 Ω resistor

$$I = \frac{6}{1+2} = \frac{6V}{3\,\Omega}$$

$I = 2$A

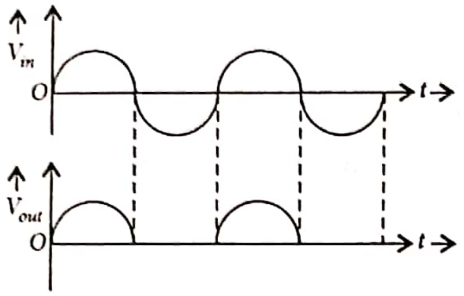
4. In microwave oven, the frequency of the microwaves is selected to match the resonant frequency of water molecules so that energy from the waves get transferred efficiently to the kinetic energy of the molecules. This kinetic energy raises the temperature of any food containing water.
Microwaves are short wavelength radio waves, with frequency of order of GHz. Due to short wavelength, they have high penetrating power with respect to atmosphere and less diffraction in the atmospheric layers. So these waves are suitable for the radar systems used in aircraft navigation.

5. Plot of potential energy of a pair of nucleons as a function of their separation is given in the figure.



Conclusions: (i) The nuclear force is much stronger than the coulomb force acting between charges or the gravitational forces between masses.
(ii) The nuclear force between two nucleons falls rapidly to zero as their distance is more than a few fermies.
(iii) For a separation greater than r_0, the force is attractive and for separation less than r_0, the force is strongly repulsive.

It consists of a diode D connected in series with load resistor R_L across the secondary windings of a step-down transformer. Primary of transformer is connected to a.c. supply. During positive half cycle of input a.c., end A of the secondary winding becomes positive and end B negative. Thus, diode D becomes forward biased and conducts the current through it. So, current in the circuit flows from A to B through load resistor R_L.



During negative half cycle of input a.c., end A of the secondary winding becomes negative and end B positive. Thus, diode D becomes reverse biased and does not conduct any current. So, no current flows in the circuit. Since electric current through load R_L flows only during positive half cycle, in one direction only *i.e.*, from A to B, so d.c. is obtained across R_L.

10. Let the mass of each particle be m.

If K_A and K_B are their kinetic energies, then

$$\lambda_A = \frac{h}{\sqrt{2mK_A}} \text{ and } \lambda_B = \frac{h}{\sqrt{2mK_B}}$$

$$\therefore \quad \frac{\lambda_A}{\lambda_B} = \frac{h/\sqrt{2mK_A}}{h/\sqrt{2mK_B}} = \sqrt{\frac{K_B}{K_A}}$$

$$\text{or} \quad \frac{K_B}{K_A} = \left(\frac{\lambda_A}{\lambda_B}\right)^2 = \left(\frac{k}{1}\right)^2 \quad \text{or} \quad \frac{K_A}{K_B} = \frac{1}{k^2}$$

As per question $\dfrac{U_A}{U_B} = \dfrac{1}{k^2}$

$$\therefore \quad \frac{K_A}{K_B} = \frac{U_A}{U_B} \quad \text{or} \quad \frac{K_A}{U_A} = \frac{K_B}{U_B}$$

Adding 1 on both sides, we get

$$\frac{K_A}{U_A} + 1 = \frac{K_B}{U_B} + 1 \quad \text{or} \quad \frac{K_A + U_A}{U_A} = \frac{K_B + U_B}{U_B}$$

$$\text{or} \quad \frac{E_A}{U_A} = \frac{E_B}{U_B} \quad \text{or} \quad \frac{E_A}{E_B} = \frac{U_A}{U_B} = \frac{1}{k^2}$$

or $E_A : E_B = 1 : k^2$

11. The minimum energy, required to free the electron from the ground state of the hydrogen atom, is known as ionization energy of that atom.

$E_0 = \dfrac{me^4}{8\varepsilon_0^2 h^2}$ *i.e.*,. $E_0 \propto m$, so when electron in hydrogen atom is replaced by a particle of mass 200 times that of the electron, ionization energy increases by 200 times.

OR

$$h\upsilon = \frac{hc}{\lambda} = (E_2 - E_1) \text{ or } \lambda = \frac{hc}{(E_2 - E_1)}$$

$$\therefore \quad \lambda = \left[\frac{6.63 \times 10^{-34} \times 3 \times 10^8}{[-0.85 - (-3.4)] \times 1.6 \times 10^{-19}}\right] \text{m}$$

$= 4.875 \times 10^{-7}$ m $= 4875$ Å

This wavelength belongs to Balmer series.

12. (i) **(b)** : Each half lens will form an image in the same plane. The optic axes of the lenses are displaced,

$$\frac{1}{v} - \frac{1}{(-30)} = \frac{1}{20}; v = 60 \text{ cm}$$

(ii) **(a)** : Here $f_1 = 20$ cm ; $f_2 = ?$

$F = 80$ cm

$$\text{As } \frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{F} \Rightarrow \frac{1}{f_2} = \frac{1}{F} - \frac{1}{f_1}$$

$$\frac{1}{f_2} = \frac{1}{80} - \frac{1}{20} = \frac{-3}{80}$$

$$f_2 = \frac{-80}{3} = -26.7 \text{ cm}$$

(iii) **(b)** : The bubble behaves like a diverging lens.

(iv) **(b)** : Convex lens is used in magnifying glass.

(v) **(d)**

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