Ge : $\lambda = 0 - 17760$ Å , Ag : $\lambda = 0 - \infty$.

SHORT ANSWERED QUESTIONS

1. **What is an energy band ?**

Ans. The almost continuous assembly of the splitted energy levels of the atoms of a solid is called energy band.

2. **What is the difference in separations of conduction and valence bands in case of conductors, insulators and semiconductors ?**

Ans. Conduction and valence bands are overlapping for conductors, widely separated (by ≈ 3 – 8 eV) for insulators and narrowly separated (by ≈ 1 eV) for semiconductors.

3. **What is bloch theorem ?**

Ans. It states the eigenfunctions of the Schrodinger equation of an electron moving in a region of *periodic* potential, such as in a crystal lattice.

4. **Write Bloch theorem.**

Ans. $\psi(\vec{r}) = e^{i\vec{k}\cdot\vec{r}}\, u_k(\vec{r})$.

5. **What does Kronig-Penney model explain ?**

Ans. It explains the behaviour of electron in periodic potential, and the origin of energy bands and forbidden bands in solids.

6. **What do you mean by effective mass of an electron ?**

Ans. The behaviour of an electron in crystal lattice is like a free-electron behaviour toward external forces if its mass m is replaced by an effective mass m^*.

7. **Write expression for effective mass of electron.**

Ans. $\dfrac{1}{m^*} = \dfrac{4\pi^2}{h^2}\dfrac{d^2\varepsilon}{dk^2}$.

8. **True (T) or False (F) ?**

(i) When a large number of atoms are brought close together, the energy levels split and form energy bands.

(ii) The conduction band of a conductor is empty.

(iii) The conduction banbd of an insulator is empty.

(iv) The forbidden energy band in Si is 1-1 eV.

(v) Insulators are opaque to visible light.

(vi) At temperatures near absolute zero, the semiconductors become insulators.

(vii) Conductivity of semiconductors decreases with rise in temperature.

(viii) All one-electron eigenfunctions in an ideal crystal are Bloch functions.

(ix) Kronig-Penney model explains the behaviour of an electron in a non-uniform magnetic field. *(Meerut 2004 S, 04, 03 S)*

(x) The effective mass of an electron in a crystal lattice may be negative. *(Meerut 2005, 03)*

Ans. (i) T , (ii) F , (iii) T , (iv) T , (v) F , (vi) T , (vii) F , (viii) T , (ix) F , (x) T.

9. Fill in the blanks :

(i) The band theory of solids deals with electron motion in the ..... field of a crystal.

(ii) The motion of electron in the periodic crystal lattice gives rise to ..... . *(Meerut 2005, 03)*

(iii) Conductors have a ..... valence energy band.

(iv) In metals, there is an overlapping of ..... and ..... bands.

(v) A solid having a band completely filled and the next allowed band completely empty is called .....

(vi) Diamond band structure has an energy gap of ..... .

(vii) The energy gap for a semiconductor is ..... than for an insulator.

(viii) All metals are ..... to light of all wavelengths.

(ix) Semiconductors are opaque to visible light but transparent to ..... .

(x) Insulators are transparent to ..... light. *(Meerut 2004 S, 04, 03 S)*

(xi) Insulators are ..... to ultraviolet light.

(xii) The eigenfunctions of the Schrodinger equation of an electron moving in a crystal lattice are known as ..... .

(xiii) Kronig-Penney model explains the behaviour of an electron in a periodically-varying ..... .

(xiv) In Kronig-Penney model, the boundaries of the allowed energy range correspond to k values given by ..... .

(xv) The electron in a periodic crystal lattice move with ..... mass.

(xvi) Near the bottom of band, the effective mass of electron is ..... in sign.

Ans. (i) periodic, (ii) energy gaps, (iii) partially-filled, (iv) valence, conduction, (v) insulator, (vi) 7 eV, (vii) smaller, (viii) opaque, (ix) infrared radiation, (x) visible, (xi) opaque, (xii) Bloch functions, (xiii) potential, (xiv) $\pm n\pi/a$, (xv) effective, (xvi) positive.

OBJECTIVE QUESTIONS

1. Valence band is also the conduction band in :

(a) conductors (b) insulators

(c) semiconductors (d) none of these.

2. In metals :

(a) there is no electron gas

(b) there is no valence band

(c) Conduction and valence bands overlap

(d) there is no conduction band.

3. According to band theory of solids :

(a) insulators have overlapping bands

(b) semiconductors have overlapping bands
(c) semiconductors have few electrons in conduction band at temperatures above 0 K
(d) insulators become semiconductors above 0 K.

4. The forbidden energy gap in germanium is :
(a) 11 eV (b) 7 eV (c) 1·1 eV (d) 0·7 eV.

5. Regarding electrical conductivity; Ge, Si and C (diamond) at very low temperatures (near absolute zero) behave :
(a) all the three as conductors
(b) all the three as insulators
(c) Ge and Si as conductors, C as insulator
(d) Ge and Si as insulators, C as conductor.

6. Metals are opaque to :
(a) light of all wavelengths (b) visible light only
(c) ultraviolet radiation only (d) infra-red radiation only.

7. The energy gap of a crystal which is transparent only to the light of wavelengths longer than 12345 Å is :
(a) 0·7 eV (b) 1·0 eV (c) 1·1 eV (d) 7 eV.

ANSWERS

1. (a) 2. (c) 3. (c) 4. (d) 5. (b) 6. (a) 7. (b).