Electronics

SET Self Evaluation Test - 27

1. In a pure silicon ($n_i = 10^{16}/m^3$) crystal at 300 K, 10^{21} atoms of phosphorus are added per cubic meter. The new hole concentration will be

(a) 10^{21} per m^3 (b) 10^{19} per m^3

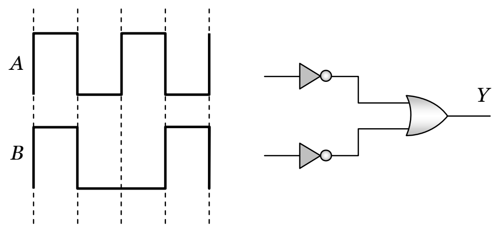
(c) 10^{11} per m^3 (d) 10^5 per m^3

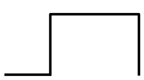
2. In the Boolean algebra $(\overline{\overline{A} \cdot \overline{B}}) \cdot A$ equals to

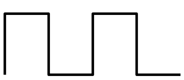
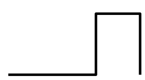
(a) $\overline{A+B}$ (b) A

(c) $\overline{A \cdot B}$ (d) $A+B$

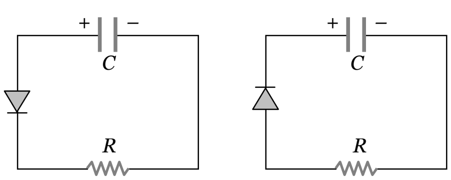
3. In a given circuit as shown the two input waveform A and B are applied simultaneously. The resultant waveform Y is



(a)  (b) 

(c)  (d) 

4. Two identical capacitors A and B are charged to the same potential V and are connected in two circuits at t = 0, as shown in figure. The charge on the capacitors at time t = CR are respectively



(i) (ii)

(a) VC, VC (b) $\frac{VC}{e}, VC$

(c) $VC, \frac{VC}{e}$ (d) $\frac{VC}{e}, \frac{VC}{e}$

5. In transistor, forward bias is always smaller than the reverse bias. The correct reason is

(a) To avoid excessive heating of transistor

(b) To maintain a constant base current

(c) To produce large voltage gain

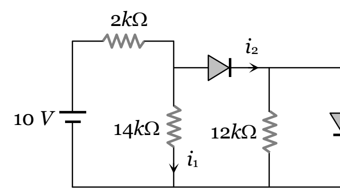
(d) None of these

6. In NPN transistor, if doping in base region is increased then collector current

(a) Increases (b) Decreases

(c) Remain same (d) None of these

7. In the following circuit I_1 and I_2 are respectively



(a) 0, 0

(b) 5 mA, 5 mA

(c) 5 mA, 0

(d) 0, 5 mA

8. In space charge limited region, the plate current in a diode is 10 mA for plate voltage 150 V. If the plate voltage is increased to 600 V, then the plate current will be

(a) 10 mA (b) 40 mA

(c) 80 mA (d) 160 mA

9. A triode has a plate resistance of 10 $k\Omega$ and amplification factor 24. If the input signal voltage is 0.4 V ($r.m.s.$), and the load resistance is 10 k ohm, then, the output voltage ($r.m.s.$) is

(a) 4.8 V (b) 9.6 V

(c) 12.0 V (d) None of these

10. Pure sodium (Na) is a good conductor of electricity because the 3s and 3p atomic bands overlap to form a partially filled conduction band. By contrast the ionic sodium chloride ($NaCl$) crystal is

(a) Insulator (b) Conductor

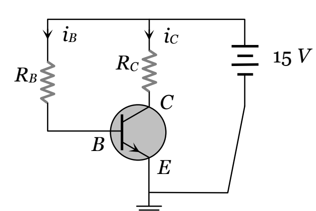
(c) Semiconductor (d) None of these

11. Would there be any advantage to adding n-type or p-type impurities to copper

(a) Yes (b) No

(c) May be (d) Information is insufficient

12. In the following common emitter circuit if β = 100, V_{CE} = 7V, V_{BE} = Negligible R_C = 2 $k\Omega$ then I_B = ?



(a) 0.01 mA

(b) 0.04 mA

(c) 0.02 mA

(d) 0.03 mA

13. When a battery is connected to a P-type semiconductor with a metallic wire, the current in the semiconductor (predominantly), inside the metallic wire and that inside the battery respectively due to

(a) Holes, electrons, ions (b) Holes, ions, electrons

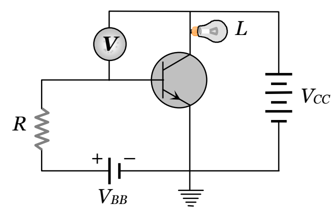
(c) Electrons, ions, holes (d) Ions, electrons, holes

14. Is the ionisation energy of an isolated free atom different from the ionisation energy E_g for the atoms in a crystalline lattice

(a) Yes (b) No

(c) May be (d) None of these

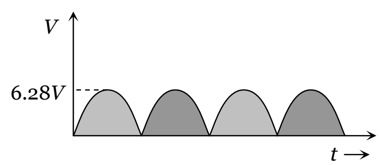
15. In the following circuit, a voltmeter V is connected across a lamp L. What change would occur in voltmeter reading if the resistance R is reduced in value



(a) Increases (b) Decreases

(c) Remains same (d) None of these

16. For given electric voltage signal dc value is



(a) 6.28 V (b) 3.14 V

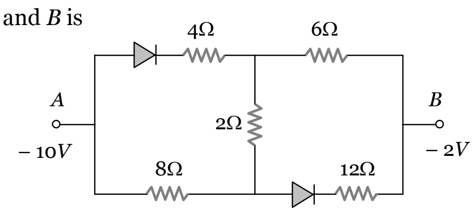
(c) 4 V (d) 0 V

17. When a silicon PN junction is in forward biased condition with series resistance, it has knee voltage of 0.6 V. Current flow in it is 5 mA, when PN junction is connected with 2.6V battery, the value of series resistance is

(a) 100 Ω (b) 200 Ω

(c) 400 Ω (d) 500 Ω

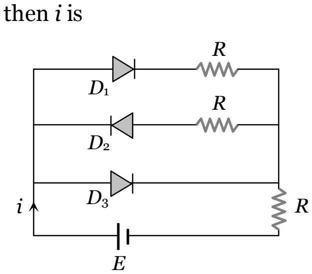
18. In the following circuit the equivalent resistance between A and B is



(a) $\frac{20}{3}\Omega$ (b) 10 Ω

(c) 16 Ω (d) 20 Ω

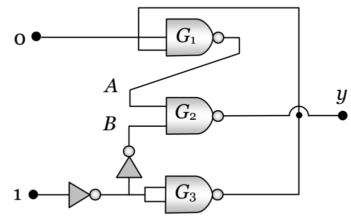
19. In the following circuit of PN junction diodes D_1, D_2 and D_3 are ideal then i is



(a) E/R (b) $E/2R$

(c) $2E/3R$ (d) Zero

20. In circuit in following fig. the value of Y is



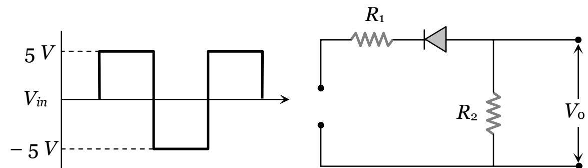
(a) 0

(b) 1

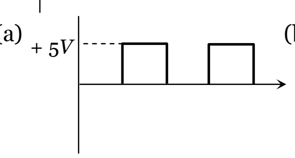
(c) Fluctuates between 0 and 1

(d) Indeterminate as the circuit can't be realised

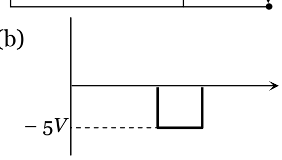
21. A waveform shown when applied to the following circuit will produce which of the following output waveform. Assuming ideal diode configuration and $R_1 = R_2$



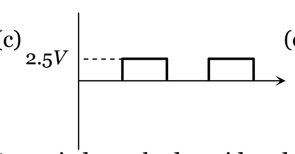
(a)



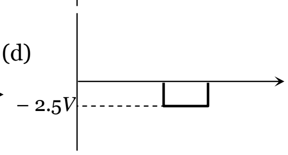
(b)



(c)



(d)



22. In a triode, cathode, grid and plate are at 0, – 2 and 80 V respectively. The electrons is emitted from the cathode with energy 3 eV. The energy of the electron reaching the plate is

(a) 77 eV (b) 85 eV

(c) 81 eV (d) 83 eV

23. The energy gap of silicon is 1.5 eV. At what wavelength the silicon will stop to absorb the photon

(a) 8250 Å (b) 7250 Å

(c) 6875.5 Å (d) 5000 Å

Answers and Solutions

(SET -27)

1. (c) By using mass action law $n_i^2 = n_e n_h$

$$\Rightarrow n_h = \frac{n_i^2}{n_e} = \frac{(10^{16})^2}{10^{21}} = 10^{11} \; per \; m^3$$

2. (b) $(\overline{\overline{A} \cdot \overline{B}}) \cdot A = (\overline{\overline{A}} + \overline{\overline{B}}) \cdot A = (A + B) \cdot A$

$= A{\cdot}A + AB = A + AB = A(1 + B) = A$

3. (a) (1 = high, 0 = low)

Input to A is in the sequence, 1,0,1,0.

Input to B is in the sequence, 1, 0, 0, 1.

Sequence is inverted by NOT gate.

Thus inputs to OR gate becomes 0, 1, 0, 1 and output of OR gate becomes 0, 1, 1, 1

Since for OR gate 0 + 1 = 1. Hence choice (a) is correct.

4. (b) Time $t = CR$ is known as time constant. It is time in which charge on the capacitor decreases to $\frac{1}{e}$ times of it's initial charge (steady state charge).

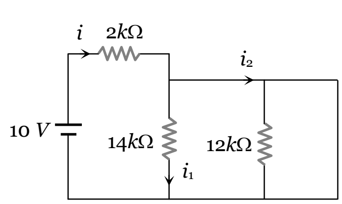
In figure (i) PN junction diode is in forward bias, so current will flow the circuit *i.e.*, charge on the capacitor decrease and in time t it becomes $Q = \frac{1}{e}(Q_o)$; where $Q_o = CV \Rightarrow Q = \frac{CV}{e}$

In figure (ii) P-N junction diode is in reverse bias, so no current will flow through the circuit hence change on capacitor will not decay and it remains same *i.e.* CV after time t.

5. (a) If forward bias is made large, the majority charge carriers would move from the emitter to the collector through the base with high velocity. This would give rise to excessive heat causing damage to transistor.

6. (b) Number of holes in base region increases hence recombination of electron and hole are also increases in this region. As result base current increases which in turn decreases the collector current.

7. (d) Equivalent circuit can be redrawn as follows



$i = \frac{10}{2} = 5\,mA = i_2$

$i_1 = 0$

8. (c) In space charge limited region, the plate current is given by Child's law $i_p = KV_p^{3/2}$

Thus, $\frac{i_{p_2}}{i_{p_1}} = \left(\frac{V_{p_2}}{V_{p_1}}\right)^{3/2} = \left(\frac{600}{150}\right)^{3/2} = (4)^{3/2} = 8$

or $i_{p_2} = i_{p_1} \times 8 = 10 \times 8 \; mA = 80 \; mA$.

9. (a) Use $V_0 = AV_s$

Now $A = \frac{24 \times 10k}{10k + 10k} = \frac{24 \times 10}{20} = 12$

Therefore, $V_0 = 12 \times 0.4 = 4.8 \; volt \; (r.m.s.)$

10. (a) In sodium chloride the Na^+ and Cl^- ions both have noble gas electron configuration corresponding to completely filled bands. Since the bands do not overlap, there must be a gap between the filled bands and the empty bands above them, so $NaCl$ is an insulator.

11. (b) Pure Cu is already an excellent conductor, since it has a partially filled conduction band, furthermore, Cu forms a metallic crystal as opposed to the covalent crystals of silicon or germanium, so the scheme of using an impurity to donate or accept an electron does not work for copper. In fact adding impurities to copper decreases the conductivity because an impurity tends to scatter electrons, impeding the flow of current.

12. (b) $V = V_{CE} + I_C R_L$

$\Rightarrow 15 = 7 + I_C \times 2 \times 10^3 \Rightarrow i_C = 4 \; mA$

$\because \; \beta = \frac{i_C}{i_B} \Rightarrow i_B = \frac{4}{100} = 0.04 \; mA$

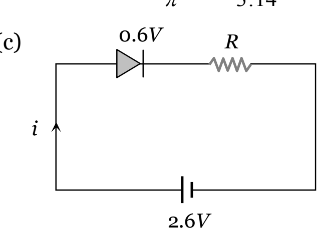
13. (a) Charge carriers inside the P-type semiconductor are holes (mainly). Inside the conductor charge carriers are electrons and for cell ions are the charge carriers.

14. (a) The ionisation energy of an isolated atom is different from it's value in crystalline lattice, because in the latter case each bound electron is influenced by many atoms in the periodic crystalline lattice.

15. (a) Here the emitter base junction of N-P-N transistor is forward biased with battery V_{BB} through resistance R. When the value of R is reduced, then the emitter current i_e will increase. As a result the collector current will also increase. ($i_c = i_e - i_b$). Due to increase in i_c, the potential difference across L increases and hence the reading of voltmeter will increases.

16. (c) $V_{dc} = V_{ac} = \frac{2V_0}{\pi} = \frac{2 \times 6.28}{3.14} = 4\,V$.

17. (c)

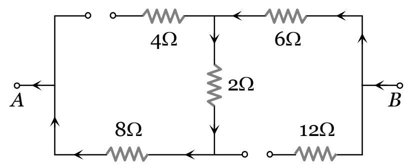


$$R = \frac{(2.6 - 0.6)}{5 \times 10^{-3}} = 400\ \Omega.$$

18. (c) According to the given figure A is at lower potential *w.r.t.* B. Hence both diodes are in reverse biasing, so equivalent, circuit can be redrawn as follows.

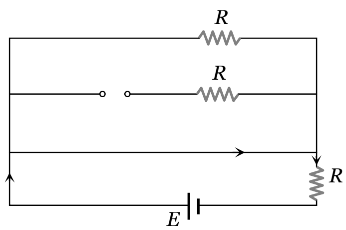
$\Rightarrow$ Equivalent resistance between A and B

$R = 8 + 2 + 6 = 16\ \Omega$.



19. (a) Diodes D_1 and D_3 are forward biased and D_2 is reverse biased so the circuit can be redrawn as follows.

$\Rightarrow i = \frac{E}{R}$



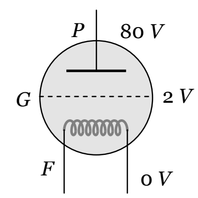
20. (a) Lower NOT gate inverts input to zero. NOT gate from NAND gate inverts this output to 1 upper NAND gate converts this input 1 and input 0 to 1.

Thus $A = 1$ and $B = 1$ become inputs of NAND gate giving final output as zero. Choice A is correct.

21. (d) The P-N junction will conduct only when it is forward biased *i.e.* when $-5V$ is fed to it, so it will conduct only for 3rd quarter part of signal shown and when it conducts potential drop 5 *volt* will be across both the resistors, so output voltage across R_2 is 2.5 V.

$\therefore\ V_0 = -2.5\ V$

22. (d) There is a loss of kinetic energy of 2 eV from filament to grid. The energy of the electron after passing through the grid will be $3 - 2 = 1\ eV$



The potential difference between plate and grid is $80 - (-2) = 82\,V$. The electron will gain energy 82 eV from the grid to the plate. The energy of electron reaching the plate $= 1 + 82 = 83\ eV$

23. (a) $\lambda = \frac{hc}{E} = \frac{6.6 \times 10^{-34} \times 3 \times 10^{8}}{1.5 \times 1.6 \times 10^{-19}} = 8.25 \times 10^{-7}\,m = 8250\ \mathring{A}$

The photon having wavelength equal to 8250Å or more than this will not able to overcome the energy gap of silicon.

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