Critical Thinking

Objective Questions

1. A silicon speciman is made into a *P*-type semiconductor by dopping, on an average, one Indium atom per 5×10^7 silicon atoms. If the number density of atoms in the silicon specimen is 5×10^{28} atoms/ m^3 then the number of acceptor atoms in silicon per cubic centimetre will be

[MP PMT 1993, 2003]

(a) 2.5×10^{30} *atoms*/ cm^3 (b) 1.0×10^{13} *atoms*/ cm^3

(c) 1.0×10^{15} *atoms*/ cm^3 (d) 2.5×10^{36} *atoms*/ cm^3

2. The probability of electrons to be found in the conduction band of an intrinsic semiconductor at a finite temperature

[IIT-JEE 1995; DPMT 2004]

(a) Decreases exponentially with increasing band gap

(b) Increases exponentially with increasing band gap

(c) Decreases with increasing temperature

(d) Is independent of the temperature and the band gap

3. The typical ionisation energy of a donor in silicon is

[IIT-JEE 1992]

(a) 10.0 *eV* (b) 1.0 *eV*

(c) 0.1 *eV* (d) 0.001 *eV*

4. In *PN*-junction diode the reverse saturation current is 10^{-5} *amp* at $27°C$. The forward current for a voltage of 0.2 *volt* is

[MP PMT 1993]

(a) 2037.6×10^{-3} *amp* (b) 203.76×10^{-3} *amp*

(c) 20.376×10^{-3} *amp* (d) 2.0376×10^{3} *amp*

$[\exp(7.62) = 2038.6,\ K = 1.4\times10^{-23}\ J/K]$

5. When a potential difference is applied across, the current passing through

[IIT-JEE 1999]

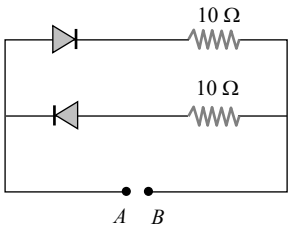
(a) An insulator at $0K$ is zero

(b) A semiconductor at $0K$ is zero

(c) A metal at $0K$ is finite

(d) A *P-N* diode at $300K$ is finite, if it is reverse biased

6. A $2V$ battery is connected across the points A and B as shown in the figure given below. Assuming that the resistance of each diode is zero in forward bias and infinity in reverse bias, the current supplied by the battery when its positive terminal is connected to A is **[UPSEAT 2002]**



(a) 0.2 *A*

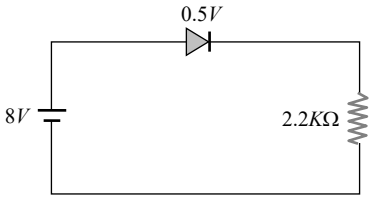
(b) 0.4 *A*

(c) Zero

(d) 0.1 *A*

7. In the circuit, if the forward voltage drop for the diode is $0.5V$, the current will be

[UPSEAT 2003]



(a) 3.4 *mA*

(b) 2 *mA*

(c) 2.5 *mA*

(d) 3 *mA*

8. A *P*-type semiconductor has acceptor levels 57 *meV* above the valence band. The maximum wavelength of light required to create a hole is (Planck's constant $h = 6.6\times10^{-34}$ *J-s*)

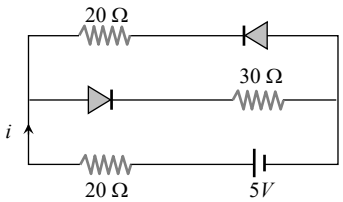
[MP PET 1995]

(a) 57 *Å* (b) 57×10^{-3} *Å*

(c) 217100 *Å* (d) 11.61×10^{-33} *Å*

9. Current in the circuit will be

[CBSE PMT 2001]



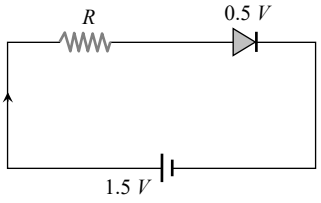
(a) $\frac{5}{40}$ *A*

(b) $\frac{5}{50}$ *A*

(c) $\frac{5}{10}$ *A*

(d) $\frac{5}{20}$ *A*

10. The diode used in the circuit shown in the figure has a constant voltage drop of 0.5 *V* at all currents and a maximum power rating of 100 *milliwatts*. What should be the value of the resistor *R*, connected in series with the diode for obtaining maximum current **[CBSE PMT 1997]**



(a) 1.5 Ω

(b) 5 Ω

(c) 6.67 Ω

(d) 200 Ω

11. For a transistor amplifier in common emitter configuration for load impedance of 1 $k\Omega$ (h_{fe} = 50 and h_{oe} = 25 $\mu A/V$) the current gain is **[AIEEE 2004]**

(a) – 5.2 (b) – 15.7

(c) – 24.8 (d) – 48.78

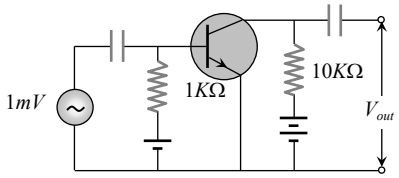
12. In the following common emitter configuration an *NPN* transistor with current gain β = 100 is used. The output voltage of the amplifier will be **[AIIMS 2003]**

(a) 10 mV

(b) 0.1 V

(c) 1.0 V

(d) 10 V



13. In semiconductor the concentrations of electrons and holes are $8 \times 10^{18}/m^3$ and $5 \times 10^{18}/m$ respectively. If the mobilities of electrons and hole are 2.3 $m^2/volt\text{-}sec$ and 0.01 $m^2/volt\text{-}sec$ respectively, then semiconductor is

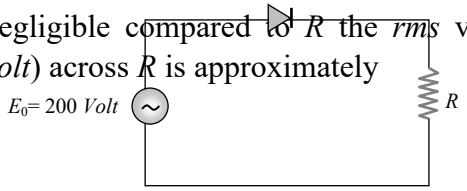
(a) *N*-type and its resistivity is 0.34 *ohm-metre*

(b) *P*-type and its resistivity is 0.034 *ohm-metre*

(c) *N*-type and its resistivity is 0.034 *ohm-metre*

(d) *P*-type and its resistivity is 3.40 *ohm-metre*

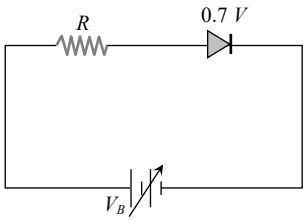
14. A sinusoidal voltage of peak value 200 *volt* is connected to a diode and resistor *R* in the circuit shown so that half wave rectification occurs. If the forward resistance of the diode is negligible compared to *R* the *rms* voltage (in *volt*) across *R* is approximately



(a) 200 (b) 100

(c) $\frac{200}{\sqrt{2}}$ (d) 280

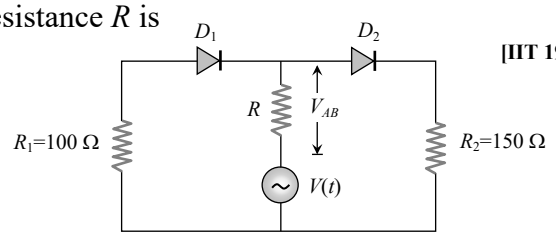
15. The junction diode in the following circuit requires a minimum current of 1 *mA* to be above the knee point (0.7 *V*) of its I-V characteristic curve. The voltage across the diode is independent of current above the knee point. If V_B = 5 *V*, then the maximum value of *R* so that the voltage is above the knee point, will be



(a) 4.3 $k\Omega$ (b) 860 $k\Omega$

(c) 4.3 Ω (d) 860 Ω

16. In the circuit given below, $V(t)$ is the sinusoidal voltage source, voltage drop $V_{AB}(t)$ across the resistance *R* is **[IIT 1993]**



(a) Is half wave rectified

(b) Is full wave rectified

(c) Has the same peak value in the positive and negative half cycles

(d) Has different peak values during positive and negative half cycle

17. The peak voltage in the output of a half-wave diode rectifier fed with a sinusoidal signal without filter is 10 *V*. The dc component of the output voltage is **[CBSE PMT 2004]**

(a) $10/\sqrt{2}\ V$ (b) $10/\pi\ V$

(c) 10 *V* (d) $20/\pi\ V$

18. A transistor is used as an amplifier in *CB* mode with a load resistance of 5 *k* Ω the current gain of amplifier is 0.98 and the input resistance is

70 Ω, the voltage gain and power gain respectively are [Pb. PET 2003]

(a) 70, 68.6 (b) 80, 75.6

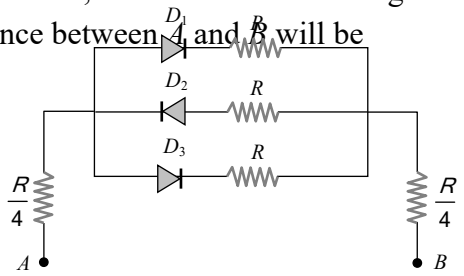
(c) 60, 66.6 (d) 90, 96.6

19. The Bohr radius of the fifth electron of phosphorus (atomic number = 15) acting as dopant in silicon (relative dielectric constant = 12) is

(a) 10.6 Å (b) 0.53 Å

(c) 21.2 Å (d) None of these

20. In the following circuits *PN*-junction diodes D_1, D_2 and D_3 are ideal for the following potential of A and B, the correct increasing order of resistance between A and B will be



(i) $-10\ V, -5V$ (ii) $-5V, -10\ V$

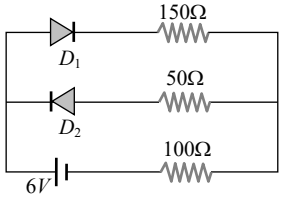
(iii) $-4V, -12V$

(a) (i) < (ii) < (iii) (b) (iii) < (ii) < (i)

(c) (ii) = (iii) < (i) (d) (i) = (iii) < (ii)

21. The circuit shown in following figure contains two diode D_1 and D_2 each with a forward resistance of 50 *ohms* and with infinite backward resistance. If the battery voltage is 6 *V*, the current through the 100 *ohm* resistance (in *amperes*) is

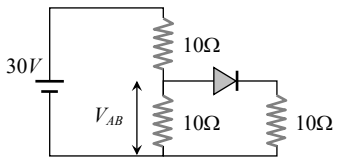
[IIT-JEE 1997]



(a) Zero (b) 0.02

(c) 0.03 (d) 0.036

22. Find V_{AB} [RPMT 2000]



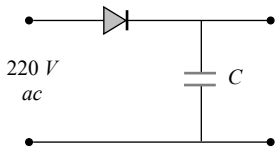
(a) 10 *V*

(b) 20 *V*

(c) 30 *V*

(d) None of these

23. A diode is connected to 220 *V* (*rms*) *ac* in series with a capacitor as shown in figure. The voltage across the capacitor is



(a) 220 *V*

(b) 110 *V*

(c) 311.1 *V*

(d) $\frac{220}{\sqrt{2}}\ V$

24. A potential difference of $2V$ is applied between the opposite faces of a *Ge* crystal plate of area 1 cm^2 and thickness 0.5 *mm*. If the concentration of electrons in *Ge* is $2 \times 10^{19}/m^3$ and mobilities of electrons and holes are $0.36\frac{m^2}{volt-\sec}$ and $0.14\frac{m^2}{volt-\sec}$ respectively, then the current flowing through the plate will be

(a) 0.25 *A* (b) 0.45 *A*

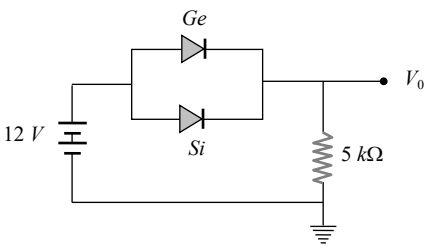
(c) 0.56 *A* (d) 0.64 *A*

25. The contribution in the total current flowing through a semiconductor due to electrons and holes are $\frac{3}{4}$ and $\frac{1}{4}$ respectively. If the drift velocity of electrons is $\frac{5}{2}$ times that of holes at this temperature, then the ratio of concentration of electrons and holes is

(a) 6 : 5 (b) 5 : 6

(c) 3 : 2 (d) 2 : 3

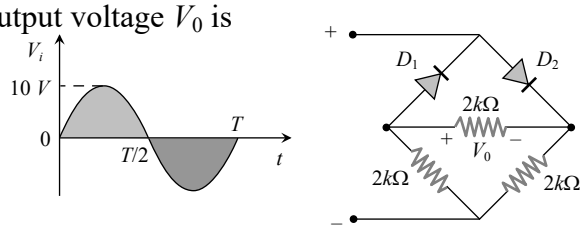
26. *Ge* and *Si* diodes conduct at 0.3 *V* and 0.7 *V* respectively. In the following figure if *Ge* diode connection are reversed, the valve of V_0 changes by [Based on Roorkee 2000]



(a) 0.2 V (b) 0.4 V

(c) 0.6 V (d) 0.8 V

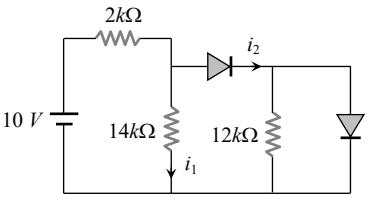
27. In the circuit shown in figure the maximum output voltage V_0 is



(a) 0 V (b) 5 V

(c) 10 V (d) $\frac{5}{\sqrt{2}}V$

28. In the following circuit find I_1 and I_2



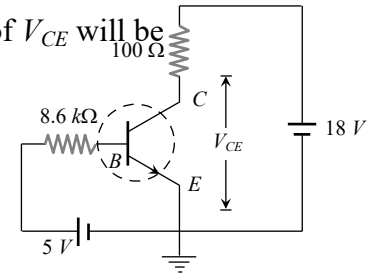
(a) 0, 0

(b) 5 mA, 5 mA

(c) 5 mA, 0

(d) 0, 5 mA

29. For the transistor circuit shown below, if β = 100, voltage drop between emitter and base is 0.7 V then value of V_{CE} will be



(a) 10 V

(b) 5 V

(c) 13 V

(d) 0 V

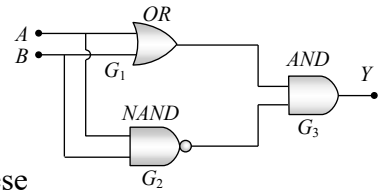
30. In NPN transistor, 10^{10} electrons enters in emitter region in 10^{-6} sec. If 2% electrons are lost in base region then collector current and current amplification factor (β) respectively are

(a) 1.57 mA, 49 (b) 1.92 mA, 70

(c) 2 mA, 25 (d) 2.25 mA, 100

31. The following configuration of gate is equivalent to

[AMU 1999]



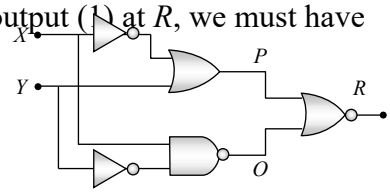
(a) NAND

(b) XOR

(c) OR

(d) None of these

32. Figure gives a system of logic gates. From the study of truth table it can be found that to produce a high output (1) at R, we must have



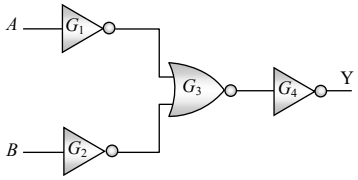
(a) $X = 0$, $Y = 1$

(b) $X = 1$, $Y = 1$

(c) $X = 1$, $Y = 0$

(d) $X = 0$, $Y = 0$

33. The combination of gates shown below produces



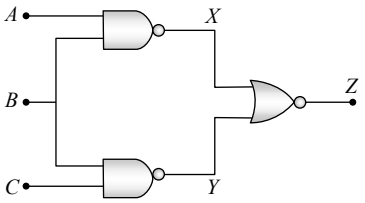
(a) AND gate

(b) XOR gate

(c) NOR gate

(d) NAND gate

34. The shows two NAND gates followed by a NOR gate. The system is equivalent to the following logic gate



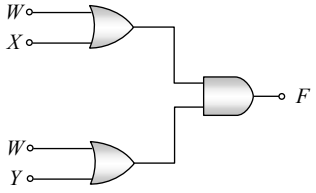
(a) OR

(b) AND

(c) NAND

(d) None of these

35. The diagram of a logic circuit is given below. The output F of the circuit is represented by



(a) $W.(X + Y)$

(b) $W.(X.Y)$

(c) $W + (X.Y)$

(d) $W + (X + Y)$

36. The plate current i_p in a triode valve is given $i_p = K(V_p + \mu V_g)^{3/2}$ where i_p is in milliampere and

V_p and V_g are in *volt*. If $r_p = 10^4$ *ohm*, and $g_m = 5 \times 10^{-3}$ *mho*, then for $i_p = 8$ *mA* and $V_p = 300$ *volt*, what is the value of K and grid cut off voltage **[Roorkee 1992]**

(a) $-6V, (30)^{3/2}$ (b) $-6\,V, (1/30)^{3/2}$

(c) $+6V, (30)^{3/2}$ (d) $+6V, (1/30)^{3/2}$

37. The linear portions of the characteristic curves of a triode valve give the following readings **[Roorkee 1985]**

V_g (*volt*)			0	– 2	– 4	– 6
I_p(*mA*) for *volts*		$V_p = 150$	15	12.5	10	7.5
I_p(*mA*) for *volts*		$V_p = 120$	10	7.5	5	2.5

The plate resistance is

(a) 2000 *ohms* (b) 4000 *ohms*

(c) 8000 *ohms* (d) 6000 *ohms*

38. The relation between dynamic plate resistance (r_p) of a vacuum diode and plate current in the space charge limited region, is

(a) $r_p \propto I_p$ (b) $r_p \propto I_p^{3/2}$

(c) $r_p \propto \frac{1}{I_p}$ (d) $r_p \propto \frac{1}{(I_p)^{1/3}}$

39. The relation between I_p and V_p for a triode is

$$I_p = (0.125\,V_p - 7.5)\,mA$$

Keeping the grid potential constant at $1V$, the value of r_p will be

(a) 8 $k\Omega$ (b) 4 $k\Omega$

(c) 2 $k\Omega$ (d) 8 $k\Omega$

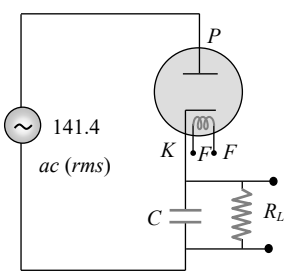
40. An alternating voltage of $141.4V$ (*rms*) is applied to a vacuum diode as shown in the figure. The maximum potential difference across the condenser will be

(a) 100 *V*

(b) 200 *V*

(c) $100\sqrt{2}\,V$

(d) $200\sqrt{2}\,V$



41. A metallic surface with work function of 2 *eV*, on heating to a temperature of 800 *K* gives an emission current of 1 *mA*. If another metallic surface having the same surface area, same emission constant but work function 4 *eV* is heated to a temperature of 1600 *K*, then the emission current will be

(a) 1 *mA* (b) 2 *mA*

(c) 4 *mA* (d) None of these

42. A change of 0.8 *mA* in the anode current of a triode occurs when the anode potential is changed by 10 *V*. If $\mu = 8$ for the triode, then what change in the grid voltage would be required to produce a change of 4 *mA* in the anode current

(a) 6.25 *V* (b) 0.16 *V*

(c) 15.2 *V* (d) None of these

43. The plate current in a triode is given by

$$I_p = 0.004\,(V_p + 10\,V_g)^{3/2}\,mA$$

where I_p, V_p and V_g are the values of plate current, plate voltage and grid voltage, respectively. What are the triode parameters μ, r_p and g_m for the operating point at $V_p = 120$ *volt* and $V_g = -2$ *volt* ?

(a) 10, 16.7 $k\Omega$, 0.6 *m mho* (b) 15, 16.7 $k\Omega$, 0.06 *m mho*

(c) 20, 6 $k\Omega$, 16.7 *m mho* (d) None of these

44. A triode whose mutual conductance is 2.5 *m A/volt* and anode resistance is 20 *kilo ohm*, is used as an amplifier whose amplification is 10. The resistance connected in plate circuit will be **[MP PET 1989; RPMT 1998]**

(a) 1 $k\Omega$ (b) 5 $k\Omega$

(c) 10 $k\Omega$ (d) 20 $k\Omega$

45. In the grid circuit of a triode a signal $E = 2\sqrt{2}\cos\omega t$ is applied. If $\mu = 14$ and $r_p = 10$ $k\Omega$ then root mean square current flowing through $R_L = 12\,k\Omega$ will be

(a) 1.27 *mA* (b) 10 *mA*

(c) 1.5 *mA* (d) 12.4 *mA*

46. For a triode $\mu = 64$ and $g_m = 1600\ \mu mho$. It is used as an amplifier and an input signal of $1V$ (*rms*) is applied. The signal power in the load of 40 $k\Omega$ will be

(a) 23.5 *mW* (b) 48.7 *mW*

(c) 25.6 *mW* (d) None of these

47. Amplification factor of a triode is 10. When the plate potential is 200 *volt* and grid potential is – 4 *volt*, then the plate current of $4mA$ is observed. If plate potential is changed to 160 *volt* and grid potential is kept at – 7 *volt*, then the plate current will be

(a) 1.69 *mA* (b) 3.95 *mA*

(c) 2.87 (d) 7.02 *mA*

48. On applying a potential of – 1 *volt* at the grid of a triode, the following relation between plate voltage V_p (*volt*) and plate current I_p(in *mA*) is found

$$I_p = 0.125\ V_p - 7.5$$

If on applying – 3 *volt* potential at grid and 300 *V* potential at plate, the plate current is found to be $5mA$, then amplification factor of the triode is

(a) 100 (b) 50

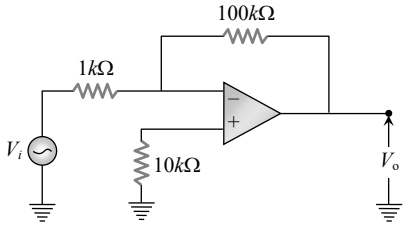
(c) 30 (d) 20

49. The slopes of anode and mutual characteristics of a triode are 0.02 $mA\ V^{-1}$ and 1 $mA\ V^{-1}$ respectively. What is the amplification factor of the valve **[MP PMT 1990]**

(a) 5 (b) 50

(c) 500 (d) 0.5

50. The voltage gain of the following amplifier is **[AIIMS 2005]**

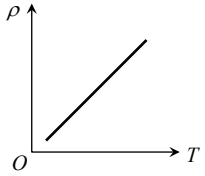


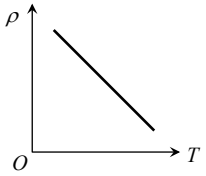
(a) 10 (b) 100

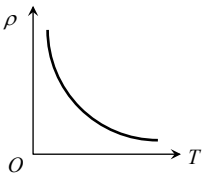
(c) 1000 (d) 9.9

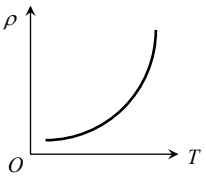
Graphical Questions

1. The temperature (T) dependence of resistivity (ρ) of a semiconductor is represented by **[AIIMS 2004]**

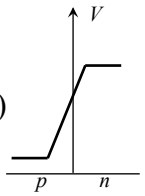
(a) 

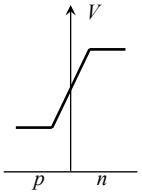
(b) 

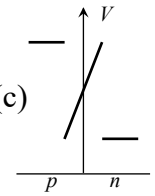
(c) 

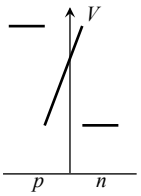
(d) 

2. In a forward biased *PN*-junction diode, the potential barrier in the depletion region is of the form … **[KCET 2004]**

(a) 

(b) 

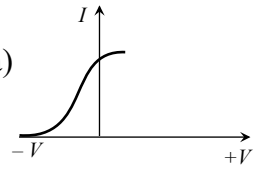
(c) 

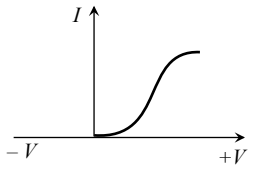
(d) 

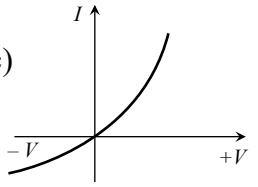
3. Different voltages are applied across a *P-N* junction and the currents are measured for each

value. Which of the following graphs is obtained between voltage and current

[MP PET 1996; UPSEAT 2002]

(a) 

(b) 

(c) 

(d)