

**2008 MAY/JUNE NBC/NTC EXAMINATIONS
MODERN QUESTIONS AND ANSWER - PHYSICS**

Question 1(a) State Newtons first and second laws of motion

- Answer 1 (a)
- (i) Newtons 1st law: states that A body will continue in its state of rest or uniform motion along a straight line unless it is acted upon by an (external) impressed force.
- (ii) Newtons 2nd Law: states that the time rate of change of momentum of a body (mass x velocity) is proportional to the resultant force acting on it (and it takes place) along the direction of action of this force.

Question 1(b) Explain the difference between force and impulse

Answer 1(b) The difference between force and impulse:

Force is that push or pull that will change or tend to change the state of rest or uniform motion of a body while impulse is the product of the (average) force acting on a body and the time duration which it acts.

OR Force – mass x acceleration while impulse = Force x time of action

OR Unit of force = Newton Unit of impulse = NS

Question 1C(i) A 100gm tennis ball was hit by a boy at a velocity 35m/s at a wall. It stopped on the wall for 6.0×10^{-3} seconds before bouncing off at a velocity of 31m/s. what was the average force the wall exerted on the ball?

Answer 1(c) i

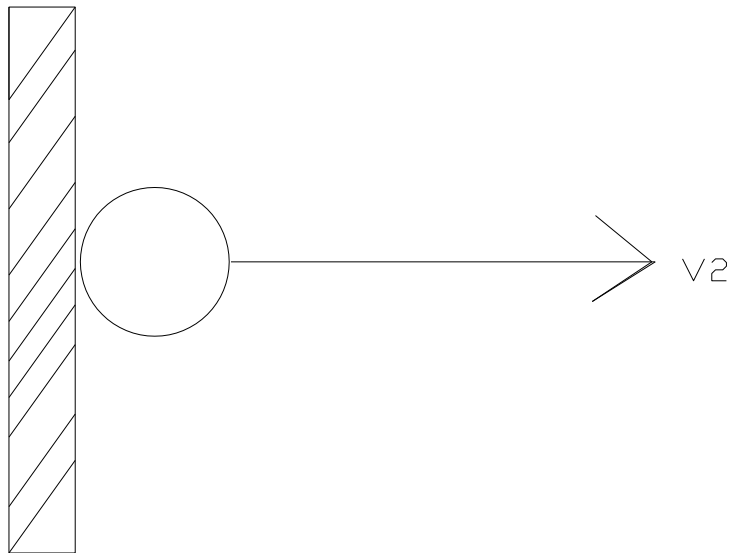
$M = 100\text{gm} = 0.1\text{kg}$

Initial Velocity $V_i = 35\text{m/s}$

Time = 6.0×10^{-3} Sec.

Final velocity $V_2 = -31\text{m/s}$

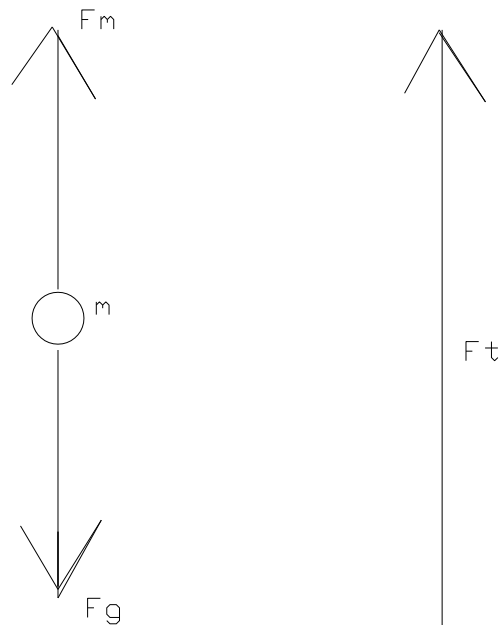
Wall



$$\begin{aligned}\text{Force } M (V) &= \frac{(V_1 - V_2)}{t} \\ &= 0.1 \frac{(35\text{m/s} - (-31\text{m/s}))}{6.0 \times 10^{-3}} \\ &= \frac{0.1 \times 66}{6.0 \times 10^{-3}} \\ &= \frac{6.6}{6.6 \times 10^{-3}} \text{ Newton} \\ F &= 1.1 \times 10^3 \text{N}\end{aligned}$$

Question 1c(ii) How much force will be needed to give a 10kg body resting on the ground an upward accelerating of 5m/s^2 if acceleration due to gravity at the place is 10.02m/s^2 ?

Answer 1c(ii)



F_m = resultant force on mass

F_g = force due to gravity

F_t = Total force applied

$M = 10\text{kg}$

$G = 10.02\text{m/s}^2$

Upward acceleration of body = 5m/s^2

$$\left. \begin{aligned} \text{But } F_m &= F_t - F_g \\ F_t &= F_m + F_g \\ &= ma + mg \end{aligned} \right\}$$

$$= (10 \times 5) + 10 \times (10.02)$$

$$= 10(15.02)$$

$$= 150.2\text{N}$$

Question 2 (i) Explain what is meant by echo and discuss how it can be used to measure the velocity of sound in air and the depth of the ocean.

Answer 2(a) (i) An echo is the sound heard after the reflection of the sound waves from a plane solid surface (hard surface).

How it can be used to measure the velocity of sound in air: Stand some distance directly in front of a vertical wall and clap two hinged wooden board sharply together and listen to hear the echo coming back from the wall. Clap repeatedly and adjust the rate of clapping until each next clap coincides with the echo heard from the previous clap. The time interval between successive claps is then equal to the time taken for sound to travel twice the distance between the clapper and the wall. After the correct rate of clapping has been achieved, use stop watch to measure the time for about 20 clap intervals. Then the average time interval between two successive claps can be got by dividing the total time interval by 20. The lateral distance between the Clapper and the wall is measured.

Let this distance be D (metres)

And let the average time interval for successive clap be t, then period of a clap and its echo equals

$$T = \frac{t}{n} \quad \text{Then velocity of sound } V = \frac{2D}{T} = \frac{2nD}{t}$$

Take the temperature of the environment because Temperature affects the velocity of sound in air.

How to use Echo to find the depth of the sea:

Ultrasonic sound impulses are sent down the depth of the sea from a ship. On board the ship is hydrophone to receive any reflection from the sea bed. The time interval between when the sound was sent and when a return sound is picked up by the hydrophone is recorded (t). If the velocity of sound in water V is known then the Depth (D) can be calculated since.

$$D = \frac{V \times t}{2}$$

(ii) From $D = \frac{Vt}{2}$

$$V = 350 \text{ m/s}$$

$$T = 3.0 \text{ sec}$$

$$D = \frac{350 \times 3.0}{2}$$

$$= \frac{1050}{2} = 525\text{m}$$

Question 2b(i) Explain what is meant by Doppler's effect.

Answer 2(b) (i) Doppler's effect can be defined as the change in the frequency of sound heard by an observer due to the relative motion of the source and the observer. An example is the roar of the motor of a racing car as it approaches and recedes from an observer at the race track. The motor seems to slow down as it passes the observer. Or also the pitch of the whistle on a fast moving train sounds higher as the train approaches the observer at a station than it does as the train passes by

Question 2b(ii) A truck moving at 120 km/hr sounded a horn of frequency 312Hz as it approaches a bus stop. What is the frequency of the horn?

- a. A stationary observer will hear
- b. An observer running towards the truck at 10m/s will hear.

Answer 2b(ii) Truck speed = $120\text{km/hr} = \frac{100\text{m/s}}{3}$

Frequency of source = 312Hz

(a) Observer stationary $v_0 = 0$

(b) Observer running towards the truck at 10m/sec

$$\text{From } \frac{f_o}{v-v_o} = \frac{f_s}{v-v_s}$$

Observer stationary $v_o = 0$

$$\frac{f_o}{v} \times \frac{f_s}{v-v_s}$$

$$f_o = \frac{v f_s}{v-v_s} = \frac{312 \times v}{v-100/3}$$

NOTE: Candidates may use 340m/s, 330m/s or 350m/s accordingly, but not speed of light.

$$= \frac{350 \times 312}{350 - 100/3} = \frac{350 \times 312 \times 3}{1050 - 100} = \frac{350 \times 312 \times 3}{950}$$

$$F_o = 344.84 \text{ hz}$$

2b (ii) Observer running towards truck at 10m/s

$$\frac{f_o}{v-v_s} = \frac{f_s}{v-v_s}$$

$$v = 350\text{m/s}; v_o = 10\text{m/s } v_s = 120\text{km/hr} = \frac{100\text{m/s}}{3}$$

$$f_o = \frac{(v + v_o) f_s}{v - v_s} = \frac{(350 + 10) \times 312}{350 - 100/3}$$

$$= \frac{360 \times 312 \times 3}{1050 - 100} = \frac{360 \times 312 \times 3}{390}$$

$$f_o = 354.69\text{hz} = 354.69 \text{ hz}$$

Question 3(a) State faraday's law of electromagnetic induction

Answer 3 (a) i. Faraday's Law of electromagnetic induction states that:

i. Whenever there is a change in the magnetic flux linked by a circuit an e.m.f. is induced in the circuit

ii. The magnitude of the induced e.m.f. or current is directly proportional to the time rate of change of the magnetic flux or lines of force linking the circuit.

$$\text{Emf} = \frac{Nd\Phi}{Dt}$$

Question 3a (ii) State Lenz's law of electromagnetic induction

Answer 3a(ii) Lenz's law states that: The induced current or (E.M.F.) always flows in such a direction as to oppose the change producing it.

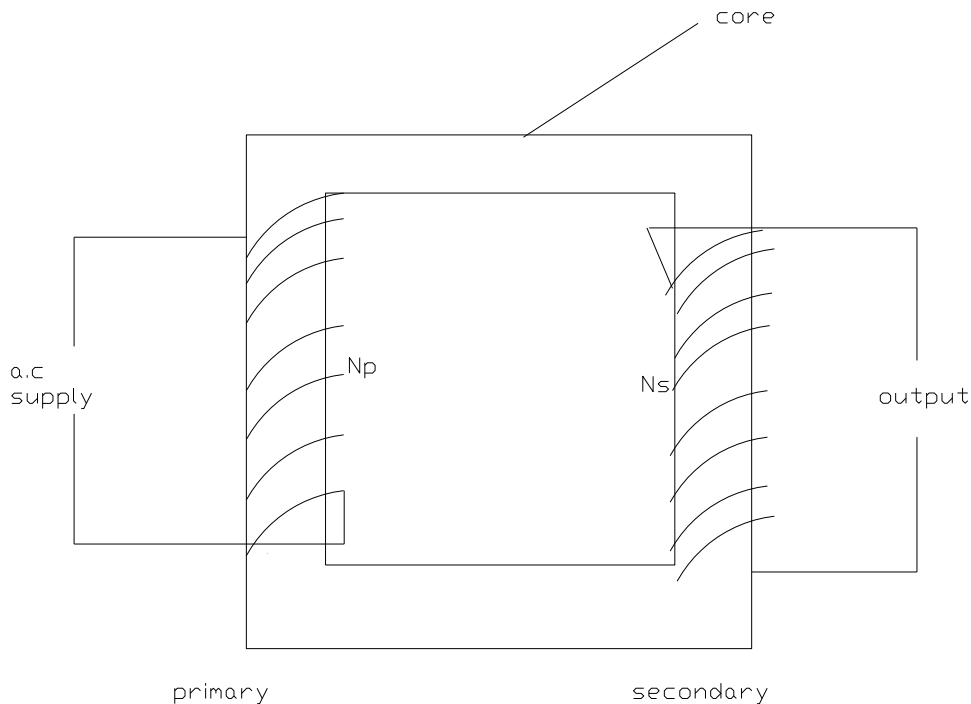
Question 3b(i) Name two electrical devices whose operation is based on the laws of electromagnetic induction.

Answer 3(b) Two electrical devices whose operation is based on the laws of electromagnetic induction are:

- i. the transformer;
 - ii. the generator;
 - iii. the induction coil.
- (Any two correct devices)

Question 3b (ii) Explain with clearly labeled diagram how a transformer works.

Answer 3b(ii)



The Transformer

When an alternative e.m.f. or a.c. voltage (E_p) is applied to the terminal of the Primary coil (P), an alternative magnetic flux is produced in the iron core which links or threads the secondary coil (S). An

alternating E.M.F. (E_s of the same frequency as that of E_p is induced in the secondary coil by mutual inductance)

The total flux linking the two coils is proportional to their number of turns N_p in the primary coil and N_s in the secondary coil.

Question 3b(iii) Mention Two sources of energy loss in a transformer and how they can be reduced.

Answer 3b(iii) Two forms of energy loss in a transformer are: (Any two)

1. eddy current
2. heat loss (I^2R)/Joules heat or copper losses.
3. Magnetic flux leakage.
4. Hysteresis

These energy loss can be reduced by

1. Eddy current can be reduced by laminating the core
2. Heat loss can be reduce by using thick wires, or low resistance wire to form the coils
3. Magnetic flux leakage - by efficient core design.
4. Hysteresis - by soft iron core or special alloy

Question 3(C) A transformer is 92.5% efficient. It is used to power a low lamp operating at 10V from a main of 220 volts a-c. What is the: (i) number of turns of the secondary coil if the primary has 200 turns.

Answer 3(C) (i) $E_s/E_p = N_s/N_p$

$$N_s = \frac{E_s N_p}{E_p} \left. \vphantom{N_s} \right\}$$

$$N_s = 10 \times \frac{200}{220}$$

$$= \underline{100}$$

11

$N_s = 9$ turns

Question 3c(ii) Power taken from the mains?

$$(ii) \text{ Efficiency } (e) = \frac{\text{output power} \times 100\%}{\text{Input power}}$$

$$E = 92.5\%; \text{ output power} = 60\text{w}$$

Input power = power taken from the mains

$$= \frac{60\text{W}}{(92.5/100)}$$

$$\text{Input power} = 60 \times 100/92.5 = 60003/92.5\text{w} = 64.87\text{w}$$

Question 4(a)i Explain using kinetic/molecular theory of matter why solid aluminium will change to liquid at 660°C without change in its temperature.

Answer 4(a)i. Molecules of solid are in fixed position in the crystalline structure. They are held together by intermolecular forces. This constraint makes them to vibrate about their mean equilibrium position. Aluminum is a solid. As the temperature of the solid Aluminium increases the atoms acquire greater kinetic energy and are able to vibrate farther apart from their mean position, thus weakening the inter molecular forces binding them together. At a certain maximum temperature (660°C) the molecules have maximum kinetic energy.

This maximum temperature is the melting point of the solid. Further heat supplied to the substance does not increase the kinetic energy of molecules. Instead the heat energy is used to break down the intermolecular forces binding the molecules together in the solid. The molecules are then free and could slide over one another. The solid then melts at this maximum temperature. Further heating only goes to break more bonds while the temperature remains constant. The heat energy absorbed during this process is known as the latent heat of fusion.

Question 4a(ii) Explain why evaporation causes cooling and give the factors which affect its rate.

Answer 4a(ii) The molecules of the liquid have an average velocity or average kinetic energy which increases with temperature. Molecules near the surface which happen to move faster than the average, escape from the attraction of their neighbours and out of the liquid. Thus the liquid loses its most energetic molecules while the less energetic ones are left behind. The average K.E. of the remaining molecules is therefore reduced, which lowers the temperature of the liquid hence evaporation causes cooling.

Factors affect evaporation are:

1. Temperature
2. Exposed area of liquid surface
3. Prevailing wind
4. Humidity
5. Prevailing atmospheric pressure

Question 4b(i) Describe an experiment to measure the specific heat capacity of a solid.

Answer 4b(i) The specific heat capacity of a solid in the form of a metal block can be determined by an electrical method and method of mixture.

(1) By Electrical Method

Two holes are bored in as the block, after which the block is weighed. A thermometer and an electrical heater are inserted in each of the holes. A little oil in each hole keeps establishing a good thermal contact with the block. The initial temperature of the block is noted and the electrical heater is switched on and current allow flowing for sometime until the temperature rises by about 15°C . the exact time of flow of a known current is measured

with a stop-watch and the initial final temperatures of the metal block are measured by the thermometer.

Heat supplied by current, $H=ivt$ jules.

Heat required to raise the temperature of block by $\theta^{\circ}\text{C} = MC\theta$

$$IVt = MC\theta$$

$$C = \frac{IVt}{M\theta} \quad \text{Jkg}^{-1}\text{k}^{-1}$$

(2) By Method of Mixture

The solid is in the form of a brass or copper block is sighted, tied to a string and left for some minutes in a beaker of boiling water. The calorimeter together with the stirrer is first weighed empty and re-weighted when it is about two thirds full of water.

The initial temperature of the water is read with the thermometer. After the solid has stayed in the boiling water for about 15 minutes it is quickly transferred into the water in the calorimeter. The calorimeter is covered with the lid; and the water is gently stirred to ensure a uniform distribution of temperature. The highest steady temperature of the mixture is read and recoded.

$$\text{Mass of solid} = M_1\text{kg}$$

$$\text{Mass of calorimeter + stirrer} = M_2\text{kg}$$

$$\text{Mass of calorimeter + stirrer + water} = M_3\text{kg}$$

$$\text{Initial temperature of water = calorimeter} = \theta_1$$

$$\text{Final temperature of mixture} = \theta_2$$

$$\text{Temperature of boiling water } 100^{\circ}\text{C}$$

$$\text{Specific heat capacity of water} = 4200\text{J.kg}^{-1}\text{k}^{-1}$$

Heat lost by solid = heat gained by water + heat gained by calorimeter and stirrer

$$M_1 \times C_1 (100-\theta_2) = (m_3-m_2) \times 4200 \times (\theta_2 - \theta_1) + M_2 \times C_2 \times (\theta-\theta_1)$$

$$C_1 = \frac{(m_3-m_2) \times 4200 \times (\theta_2-\theta_1) + M_2 C_2 (\theta-\theta_1)}{M_1 (100-\theta_2)}$$

$$M_1(100-\theta_2)$$

Initial temperature of A1 = θ

Final temperature of mixture = 10^0C

Specific heat cap of A1 = $900\text{Jkg}^{-1}\text{k}^{-1}$

Latent heat of fusion = $336 \times 10^3\text{j/kg}$

Question 4b(ii) A 100gm aluminium calorimeter contained 500gm of water and 150 gm of ice at 10^0C . a cube of very hot aluminium metal of mass 800gm was carefully added to the mixture and stirred. At equilibrium, the temperature of the entire mixture was 10^0C . what was the initial temperature of the aluminium cube?

Answer 4b(ii) $M_1 = 100\text{g} = 0.1\text{kg}$

$M_2 = 150\text{g} = 0.15\text{kg}$

$M_3 = 500\text{g} = 0.5\text{kg}$

$\theta_2 = 10^0\text{C}$, $\theta = ?$

Specific heat capacity of aluminium = $900 \text{ jkg}^{-1}\text{k}^{-1}$

Heat lost by A1 = heat gained by water + heat to ice for melt + Heat of calorimeter.

$$0.8 \times 900 \times (\theta - 10) = [0.5 \times 4200 (10 - 0) + 0.1 \times 900 (10 - 0) + 0.15 \times 4200 (10 - 0) + 0.1 \times 900 (10 - 0)]$$

$$= 0.8 \times 900 \times \theta - 0.8 \times 9000 = 2100 \times 10 + 150 \times 336 + 15 \times 42 \times 10 + 90 \times 10$$

$$720\theta - 7200 = 21000 + 50400 + 6300 + 6300 + 900$$

$$720\theta = 78600 + 7200 = 85800$$

$$\therefore \theta = \frac{85800}{720} = 119,17^0\text{C}$$

$$= 119.2^0\text{C}$$

Question 5(a) (i) Distinguish between intrinsic and extrinsic semi conductors and give TWO examples of each.

Answer 5a (i) If conduction in a material results only from the electron movement from valence to conduction band, it is called an intrinsic semiconductor. While semiconductor materials containing different types of impurities are combine to produce the many useful devices presently on the scene. The process of adding impurity to a semiconductor is called doping, and the doped semiconductor is referred to as extrinsic semi conduction.

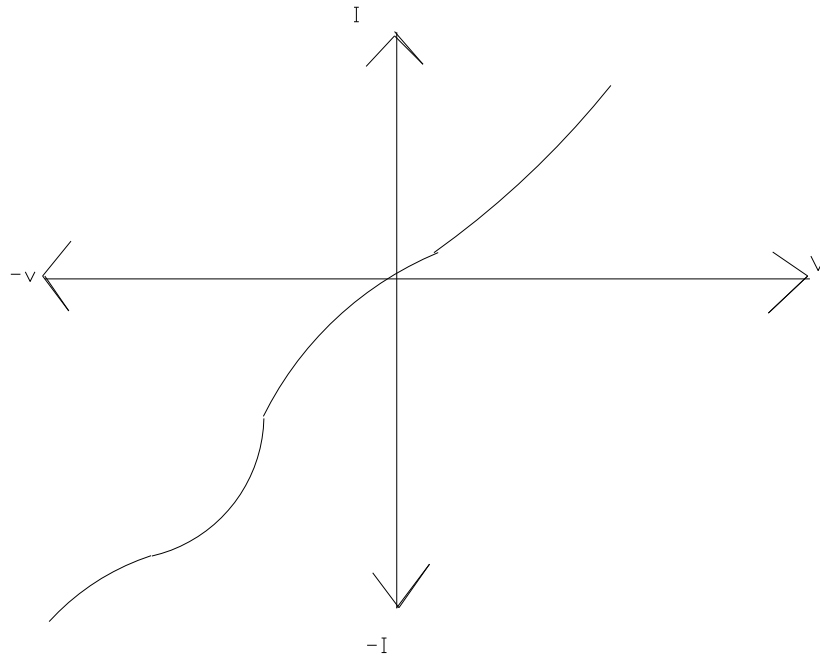
E.g. (i) Intrinsic - Pure silicon, Germinium etc.

(ii) Extrinsic: - Gallium Arsenide, (gasa), Lead Tellurium (PbTe) etc.

Question 5a(ii) What is a p-n Junction and how dos it work?

Answer 5a(ii) P-n junction consists of a p-type and n-type semiconductor in contact. When forward bias (i.e. the P-semiconductor is connected to the positive terminal of a battery and the n-Semiconductor is connected to the negative terminal of a battery, it has a low resistance to current flow. When in reverse bias (i.e. the P-Semiconductor is connected to the negative terminal of the battery and the n-Semiconductor is connected to the positive terminal) it has a high resistance to current flow

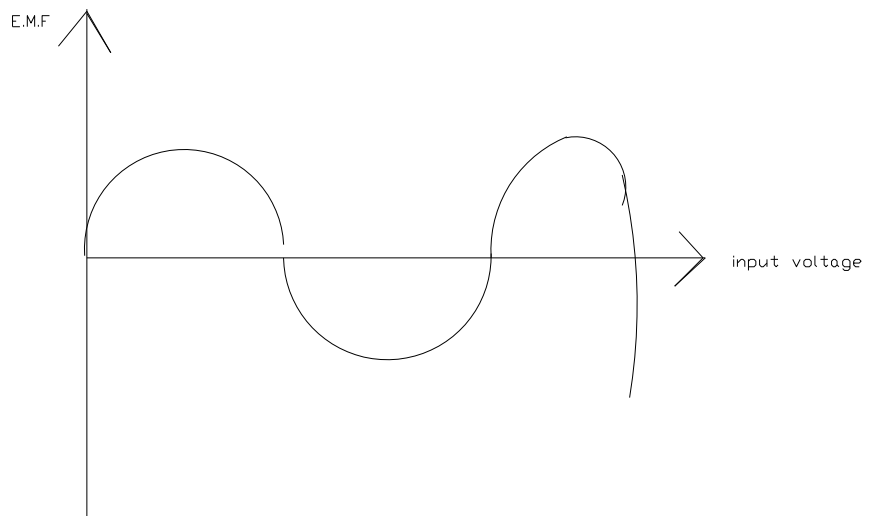
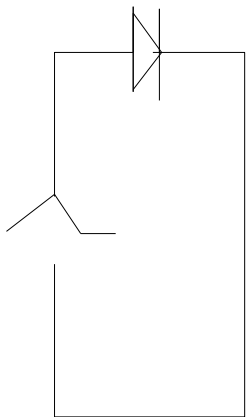
Question 5b(i) Draw the I – V characteristics of a p-n Junction and explain how it can be used for rectification

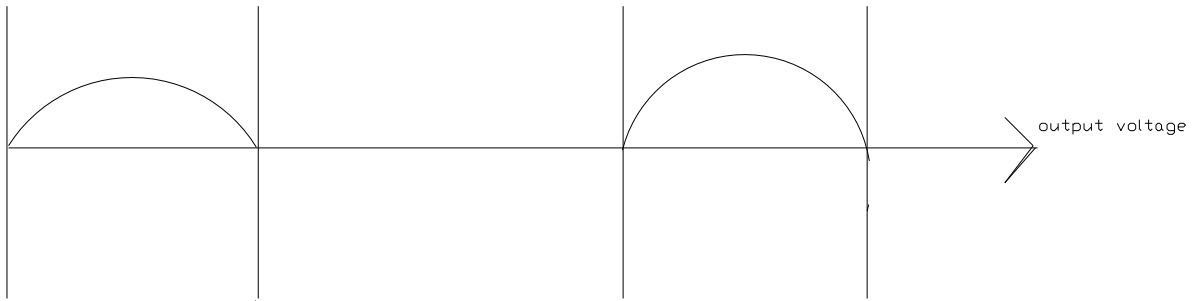


I – V Characteristic.

Question 5b(ii) What are the advantages and the disadvantages of a p-n Junction diode over a thermionic valve diode?

P-N JUNCTION AS RECTIFIER





The P-n junction device is only forward biased during one-half current flows during the period. It can be detected in the output resistance R_r . This is why the p-type is positive and n-type is negative. No current flows in the reverse cycle since the p-n junction is reversed biased. It exhibits high resistance to current flow. Current therefore flow in the resistance R_r as shown above in one direction only. This is called half wave rectification. For full wave ratification two p-n junction back to back are used.

Answer 5b(ii)

The advantages of a P – n junction diode are:

It is much smaller;

It needs only smaller P.d to operate in the radio receiver;

It is cheaper;

It requires no time to warm up to produce the current carriers since it is a semi conductor;

It can be operated with low voltage source;

It is strong and not easily destroyed;

The disadvantage of P-n junction:

It is a non-ohmic conductor;

When polarized, only a very small current flows;