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?
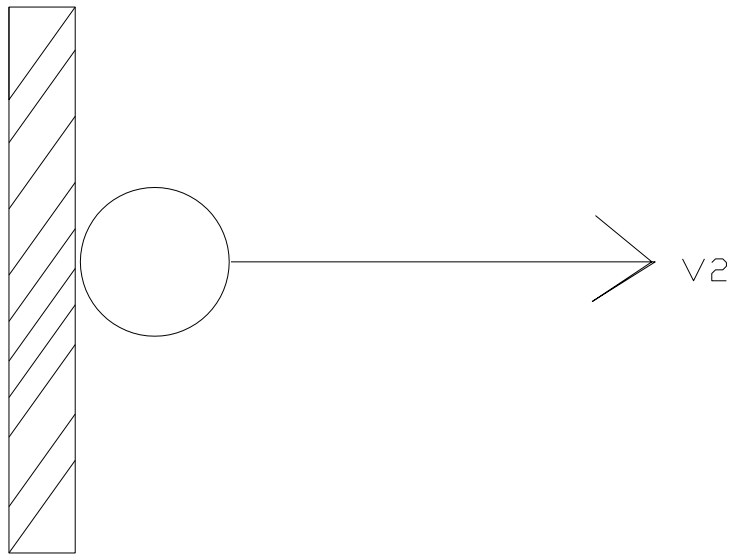
Answer 1(c) i M = 100gm = 0.1kg

Initial Velocity V_i = 35m/s

Time = 6.0×10^{-3} Sec.

Final velocity V_2 = -31m/s

Wall

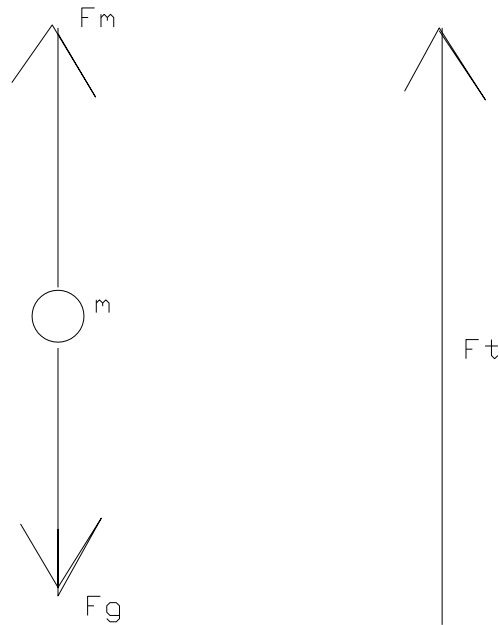Force M (V) = $\dfrac{(V_1 - V_2)}{t}$

= 0.1 $\dfrac{(35m/s - (-31m/s)}{6.0 \times 10^{-3}}$

$\dfrac{0.1 \times 66}{6.0 \times 10^{-3}}$

= $\dfrac{6.6}{6.6 \times 10^{-3}}$ Newton

F = 1.1 x 10^3N

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 = 10kg

G = $10.02m/s^2$

Upward acceleration of body = $5m/s^2$

But $F_m = F_t - F_g$

$F_t = F_m + F_g$

   $= ma + mg$

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

   $= 10(15.02)$

   $= 150.2N$

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 <u>vertical wall and clap two hinged</u> wooden board sharply

together and listen to hear the <u>echo coming back</u> from the wall. Clap <u>repeatedly</u>

and adjust the rate of clapping until each next clap coincides with the echo heard

from the previous clap. The <u>time interval</u> 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 <u>stop watch to</u>

<u>measure</u> 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

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

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   = $\dfrac{V \times t}{2}$

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

V = 350 m/s

T = 3.0 sec

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

= $\dfrac{1050}{2}$ = 525m

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 10,/s will hear.

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

Frequency of source = 312Hz

(a) Observer stationery $y_0 = 0$

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

From $\frac{Fo}{v-vo} = \frac{fs}{v-vs}$

Observer stationery Vo = 0

$\frac{Fo}{v}$ x $\frac{fs}{v-vs}$

$fo = \frac{Vfs}{v-vs} = \frac{312 \times V}{v-100/3}$

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

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

$F_o = 344.84$ hz

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

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

V = 350m/s; Vo = 10m/s Vs = 120km/hr = $\frac{100m/s}{3}$

$fo = \frac{(V + Vo)}{V-Vs}$ fs $= \frac{(350 +10) \times 312}{350-100/3}$

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

fo = 354.69hz   =   354.69 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.

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

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

Answer 3a(ii)   Lenz's law stats 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)
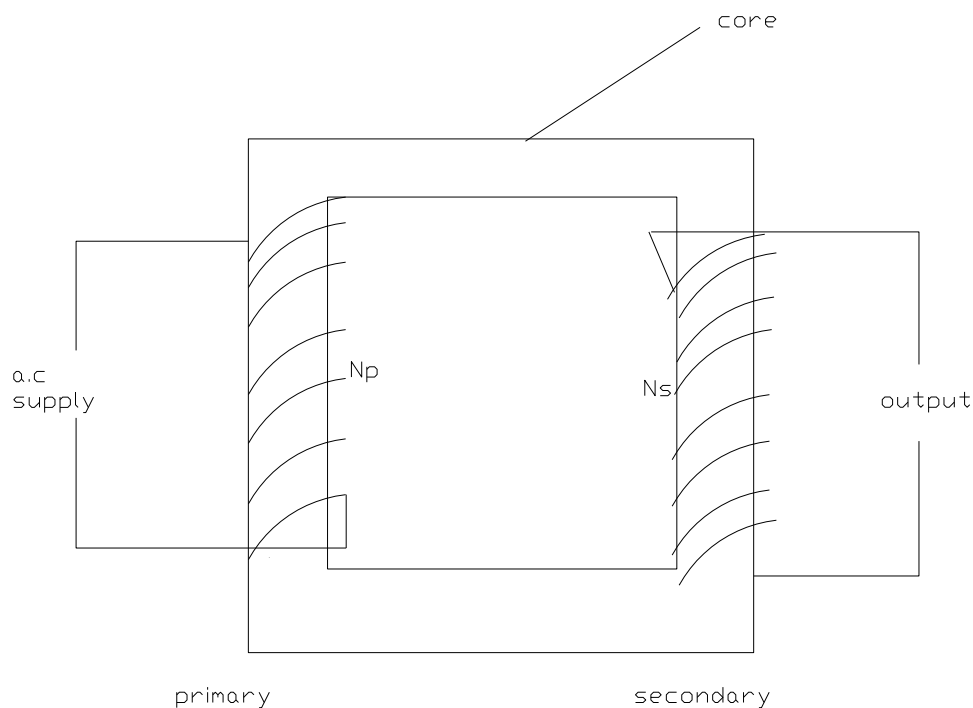
The Transformer

When an alternative e.m.f. or a.c. voltage (E_p) is applied to the terminal of the <u>Primary coil</u> (P), an

alternative <u>magnetic flux</u> is produced in the iron core which links or <u>threads the secondary coil</u> (S). An

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

The total flux linking the two coils is proportional to their number of turns Np in the primary coil and Ns 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 (1^2R)/Joules heat or copper loses.

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) Es/Ep = Ns/Np

$$Ns = \frac{EsNP}{Ep}$$

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

$$= 100$$

11

Ns = 9 turns

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

(ii) Efficiency (e) = output power x 100%
                                  Input power

E = 92.5%; output power = 60w

Input power = power taken from the mains

= 60W
  (92.5/100)

Input power = 60 x 100/92.5 = 60003/92.5w   =   64.87w

Question 4(a)i Explain using kinetic/molecular theory of matter why solid aluminium will change to

liquid at 660^0C 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 $(660^0C)$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 <u>temperature.</u> Molecules near the surface which happen to move faster then the average, <u>escape</u> from the attraction of their neighours and out of the liquid. Thus the liquid loses its most <u>energetic molecules</u> while the less energetic ones are left behind. The average K.E. of the remaining molecules is therefore <u>reduced,</u> which <u>lowers the temperature</u> of the liquid hence <u>evaporation causes cooling.</u>

              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 hearter 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 15^0C. 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 0^0C = MCθ

IVt   =   MCθ

C   = $\dfrac{IVt}{Mθ}$ $jkg^{-1}k^{-1}$

(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.

Mass of solid = M_1kg

Mass of calorimeter + stirrer = M_2kg

Mass of calorimeter + stirrer + water = M_3kg

Initial temperature of water = calorimeter = $θ_1$

Final temperature of mixture = $θ_2$

Temperature of boiling water 100^0C

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

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

$M_1 \times C_1 (100-θ_2) = (m_3-m_2) \times 4200 \times (θ_2 - θ_1) + M_2 \times C_2 \times (θ-θ_1)$

C1 = $(m_3-m_2) \times 4200 \times (θ_2-θ_1) + M_2C_2 (θ-θ_1)$

$$M_1(100-\theta_2)$$

Initial temperature of A1 = θ

Final temperature of mixture = 10^0C

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

Latent heat of fusion = 336 x 10^3j/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)   M1 = 100g = 0.1kg

M2 = 150g = 0.15kg

M3 = 500g = 0.5kg

θ2 = 10^0C, θ = ?

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

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

0.8 x 900 x (θ-10) = [0.5 x 4200 (10-0) + 0.1 x 900 (10-0)+ 0.15 x 4200 (10-0) +0.1 x 900 (10-0)]

= 0.8x900xθ-0.8x9000 = 2100 x 10 + 150 x336 + 15 x42 x 10 + 90 x 10
   7200θ-7200 = 21000 + 50400 + 6300 + 6300 + 900

7200θ = 78600 + 7200 = 85800

∴θ = 85800 / 720 = 119,17^{o}C

= 119.2^{o}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 <u>doping</u>, 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 <u>in contact</u>. 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 <u>negative terminal</u> of a battery,

it has a <u>low resistance</u> 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 <u>positive terminal</u>) it has a high resistance to
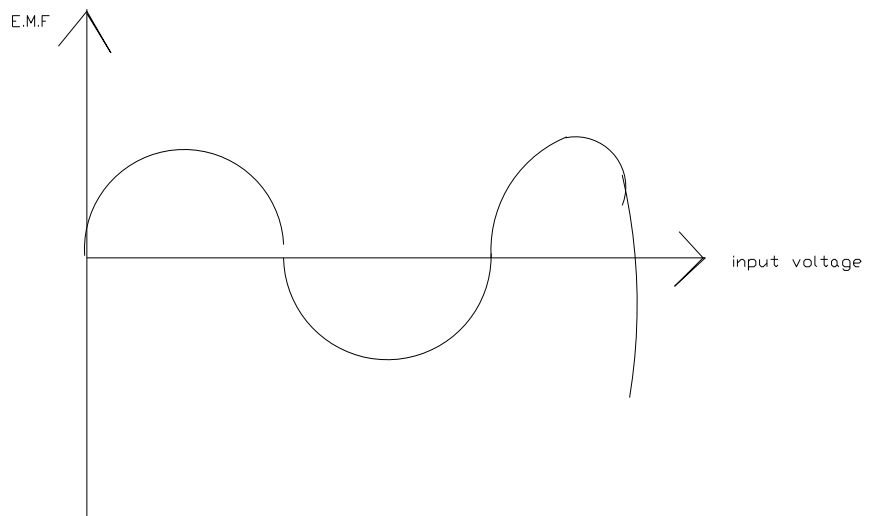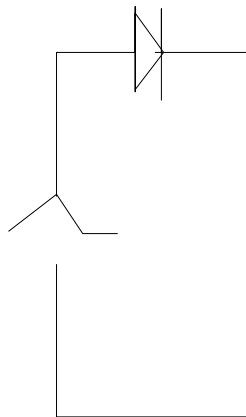
<u>current flow</u>

Question 5b(i)   Draw the I – V characteristics of a p-n Junction and explain how it can be used
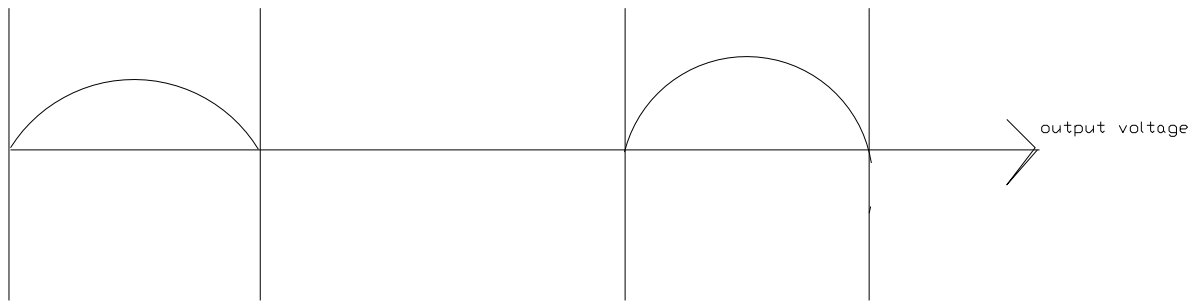
for rectification
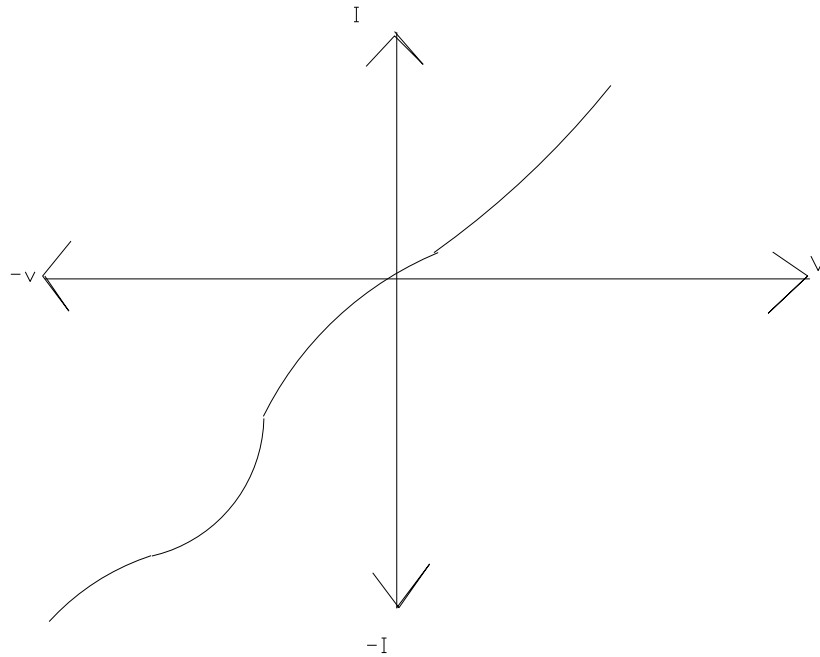
I – V Characteristic.
Question 5b(ii)   What are the advantages and the disadvantages of a p-n Junction diode over a
         thermionic valve diode?

P-N JUNCTION AS RECTIFIER

The P-n junction device is only <u>forward biased</u> during one-half current flows during the period. It can be detected in the output resistance Rr. This is why the p-type is <u>positive and n-type is negative.</u> No current flows in the <u>reverse</u> cycle since the p-n junction is reversed biased. It exhibits high resistance to current flow. Current therefore flow in the resistance Rr as shown above in one direction only. This is called <u>half wave rectification</u>. 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;