NATIONAL BUSINESS AND TECHNICAL EXAMINATIONS BOARD (NABTEB)

2006 MAY/JUNE NBC/NTC EXAMINATIONS

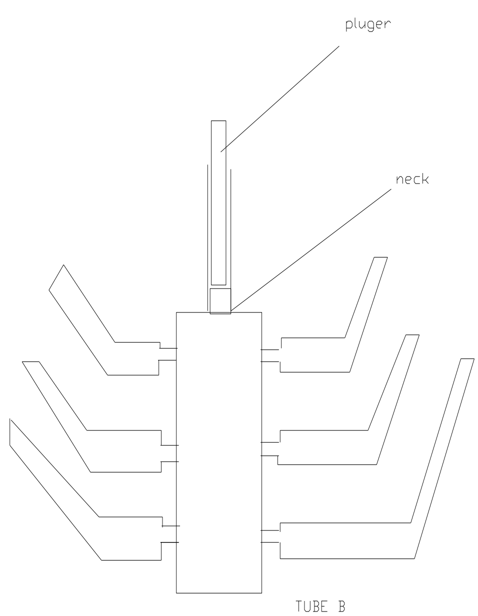
MODERN QUESTIONS AND ANSWERS – PHYSICS

Question 1 a(i) State the Pascal's principle of transmission of pressure in fluids. Describe an experiment to illustrate this law.

Answer 1 a(i) **Pascal's Principle:** States that the pressure applied to an enclosed fluid is transmitted equally to every portion of the fluid and the containing walls

OR Any change of pressure in an enclosed fluid is transmitted undiminished to all parts of the fluid.

EXPERIMENT TO ILLUSTRATE PASCAL PRINCIPLE



A hollow metal tube B is filled with water. It has a long neck N. it is fitted with a plunger and piston arrangement to exert pressure when the handle is depressed. The tube B has several outlets at different positions around its surface at different levels. (The outlet are fitted with tubers which will direct any water coming out of them upward). When the plunger is depressed, water is forced out of the outlets in all directions. It will be found that the water squatted out of these outlets all rise to the same height. (since pressure is hpg;) it shows that the pressure at each outlet must be the same. Thus showing that the excess pressure created by the movement of the plunger gave rise to equal pressures at all points of the liquid in the vessel.

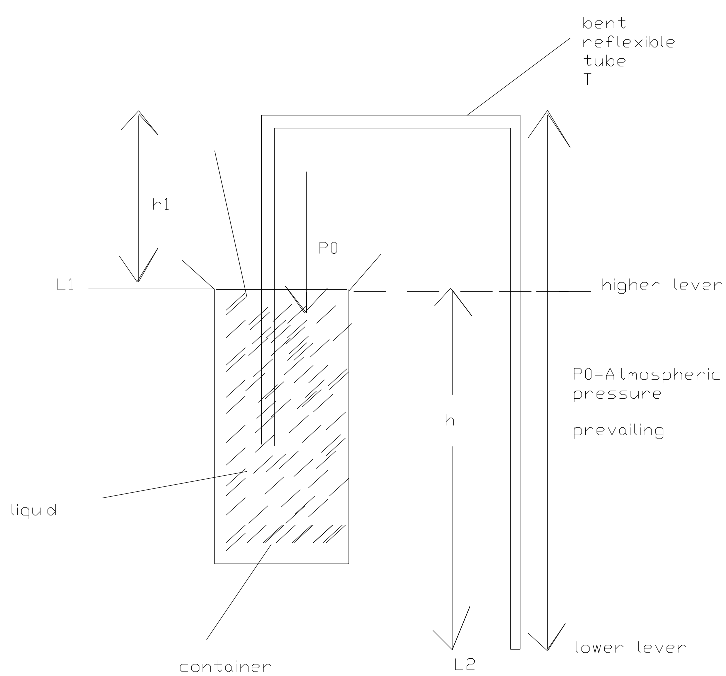
Question 1a(ii) Describe the application of this Principle in the working of car-braking system.

Answer 1a(ii) **WORKING OF A CAR BRAKING SYSTEM**

When the brake pedal is pressed by the driver, the piston in the master cylinder is pushed. This compresses the oil inside the tubes and the pressure is transmitted equally to the brake shoes by the caliper forcing the brake shoes and its pad against the brake drum to which the tyres are fixed. (The frictional force between the pad and the drum slows down the rotation of the wheels or can stop them entirely depending on how hard the driver pressed down on the pedals.) When the driver releases the brake pedal. The pressure is released. A spring connected to the two arms of the brake shoes which had been stretched by the force applied now returns, and pushed away from the drum giving clearance for the drum to rotate freely once again.

Question 1b(i) With the aid of a diagram, describe the action of a siphon.

Answer b1(i) The action of a Siphon:



The siphon is a device for emptying containers which can not be easily emptied by tipping over. E.g. Petrol from a car tank or kerosene from a keg/jerry can.

The siphon can only transfer liquids from a point at higher level to one at a lower level. It is shown in the diagram above. Liquids flow from level L_1, which is higher down to level L_2, which is lower because of the excess pressure created between L_1 and L_2. This pressure is created by first sucking out air from the bent pipe. The atmospheric pressure acting on the surface of the liquid at L_1 forces the liquid into the tube T. The resultant pressure tending to force the liquid up the tube at $L_1 = P_o$-hpg. – $h_2$pg. The net acting at

level L_2 tending to force the liquid up the tube = $P_o - h_2pg$. The pressure acting upward at L_1 is much greater than at L_2. The excess pressure driving the liquid continuously from L_1 to L_2 = $[h_2 - h_1)pg] = hpg$
h = difference in height between the two levels.

For the siphon to work:- (i) The tube must be filled with liquid (ii) The level $L_2 <$ level L_1 (iii) The height h_1 must be less than H_o; the barometric height at the place.

The principle of the siphon is what is employed in the flushing tanks in the toilets.

Question 1b(ii) Explain why water in the bottom of a floating boat cannot be siphoned over the side.

Answer 1b(ii) Water in the bottom of a floating boat cannot be siphoned over board because the level of water in the boat is less than the level outside the boat.

Question 1(c) The air pressure at the base of a mountain is 75.0cmHg and at the top is 60cmHg. Given that the average density of air is $1.25kgm^{-3}$ and the density of mercury is $13600kgm^{-3}$. Calculate the height of the mountain.

Answer 1 (c) Base of mountain H_1 = 75 cm Hg. = 75 x 10^{-2} mHg
Top of mountain H_2 = 60.0cm Hg = 60 x10^{-2}mHg
Pressure = hpg
p = density of mercury = $13600kg/m^3$
g = acceleration due to gravity
Difference in pressure between the top and bottom = $(H_1 - H_2)$ pmg

This is equal to the pressure exerted by the column of air to the top of the mountain from the base

$\therefore (H_1 - H_2)$ pmg = h air g,
P air = 1.25kg/m

$(75 - 60) \times 10^{-2} \times 13600 = h \times 1.25$

$$\therefore h = \frac{15 \times 13600 \times 10^{-2}}{1.25} = \frac{15 \times 136}{1.25}$$

h = <u>1632</u> m
The height of the mountain = <u>1632m</u>

Question 2a(i) State the laws of refraction of light

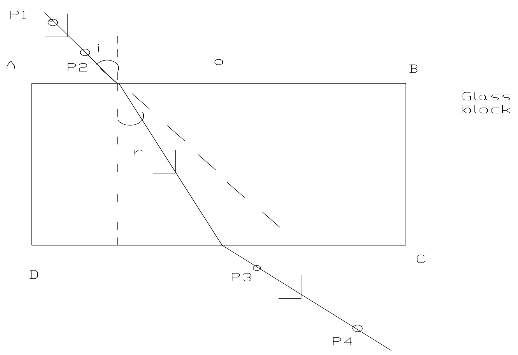
Answer 2a(i) The laws of refraction of light
(1) The incident ray, the normal at the point of incidence and the refracted ray all lie in the same plane.

(2) $\frac{\text{Sin } i}{\text{Sin} r} = \mu$ = Refractive index of the light incident on a pair of media.

Where i = angle of incidence
r = angle of refraction
OR μ = <u>velocity of Light in vacuum or air</u>

Velocity of Light in medium

Question 2a(ii) Describe how you can verify the laws, using a rectangular glass block and optical pins
.
Answer 2a(ii) Verification of the law using rectangular glass block and optical pins.



(Workability; everything 1 or zero; no arrow

Procedure: Place the rectangular glass block on a white sheet of paper firmly secured to the table or a board. Trace the side of the block on the paper. At a convenient spot draw the normal to the side AB at O. with a protractor mark out angles 10^0, 20^0, 30^0, 40^0, 50^0, to the normal drawn at O and rule lines to show these angles. Position optical pins P_1 and P_2. On the first line. Looking through the other side of the glass block side CD, look for the two optical pins in line through the block and position Pins P_3 and P_4 to be in your line of sight of Pins P_1 and P_2. Join the positions of P_3 and P_4 with a rule and pencil to touch the block at O^1. Join the points 00^1. This will make an angle r with the normal drawn at 0. With your protractor measure this angle. Repeat this procedure for the other angles of incidents (five times) and tabulate your results as follows:

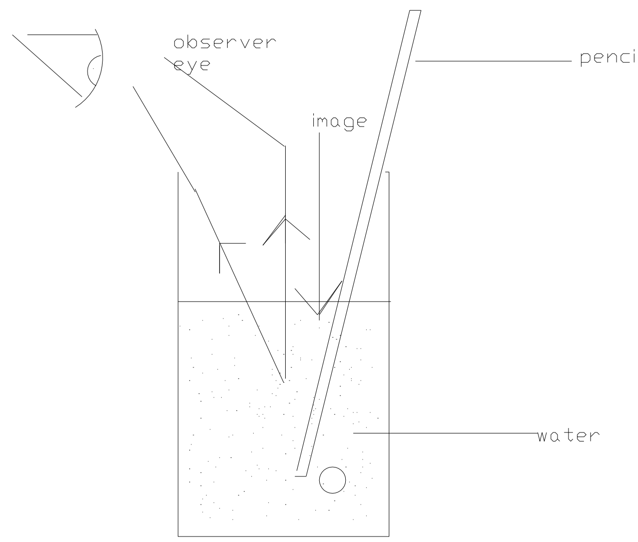
Angle of Incident i,	Angle of Refraction r	Sin i	Sin r	Sin i/sin r = μ
10				
20				
30				
40				
50				
60				

It should be found that the ratio sin i= a constant in each case.

Sin r

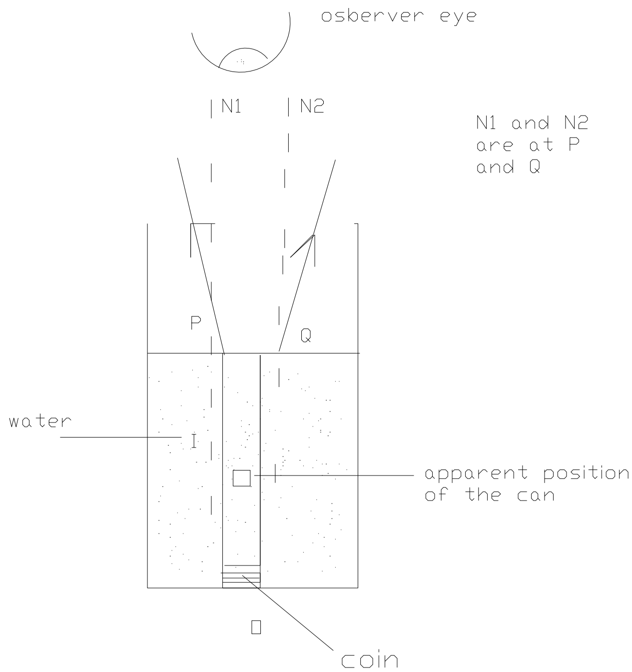
OR Plot a graph of sin i vs sin r which should be a straight line graph, passing through the origin. The slope gives the refractive index (μ).

Question 2b(i) Explain with the aid of a diagram why a straight pencil partly immersed in water appear to be bent.



Answer 2b(i) The pencil partially immersed in water, appears bent upward or broken at the water surface because the rays from different parts of it below the water surface are refracted away from the normal as they emerge from the water air surface.

Question 2 b(ii) Explain with the aid of a diagram why to an observer vertically above a pool of water, a coin at the bottom of the pool appears nearer the surface than it really is.



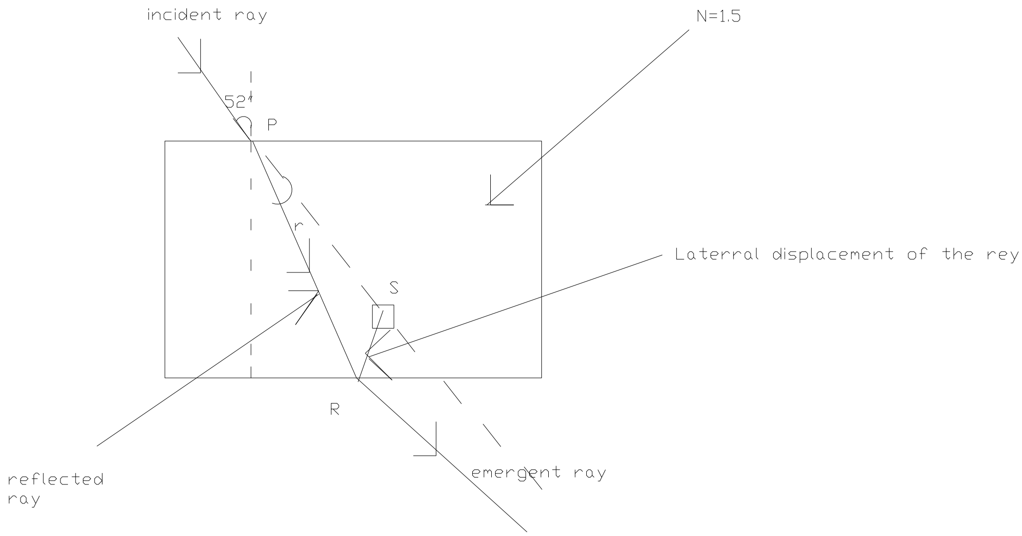
Answer 2 b(ii)

The object appears nearer the water surface than its real depth because of refraction. The rays coming from inside the water are refracted away from the normals N_1 and N_2 the coin then appears to be located at 1 instead of O as shown in the diagram.

Question 2(c) A ray of light passes from air through a rectangular block of glass with parallel faces 4.5cm apart at an angle of incidence of 52^0. Find the:

i. Lateral displacement of the ray.
ii. Angle of refraction (Refractive index of glass = 1.5)

Answer 2(c)



Angle of refraction can be obtained from snells law

$$\mu = \frac{\sin i}{\sin r} : \qquad \text{Sin } r = \frac{\text{Sin } i}{\mu}$$

$i = 52^0; \mu = 1.5$

$\therefore\ r = \frac{\sin 52^0}{1.5} = 0.5253$

$\therefore\ r = \sin^{-1} 0.5253 = 31.69^0 = 31.7^0$

Lateral displacement = $\frac{t \sin (i - r)}{\cos r}$

Angle of refraction $r = 31.7^0$

Lateral displacement = RS in the diagram

$\frac{RS}{PR} = \sin(i - r) = \sin(52^0 - 31.7^0)$

Also $\frac{PQ}{PR} = \cos r \therefore PR = \frac{PQ}{\cos r}$ PQ = 4.5cm

$\therefore RS = PR \sin(52^0 - 31.7^0)$

$= \frac{PQ}{\text{Cos } r} \sin(52^0 - 31.7^0) = \frac{4.5 \sin(52^0 - 31.7^0) \text{ cm}}{\cos 31.7^0}$

RS = 1.83497cm = 1.84 cm

Lateral displacement of the Ray = 1.84cm

Question 3(a) Explain what is meant by a field

Answer 3(a): By a field, it is meant a region of space under the influence of some physical agency such as gravitation, magnetism and electricity.

Question 3(b) Mention three types of fields known to you

Answer 3(b) Three types of fields are (1) Gravitational field (2) magnetic field (3) electrostatic field (4) electromagnetic field. (Any 3 is correct)

Question 3(c) Distinguish between scalar fields and vector fields. Give two examples of each.

Answer 3(c) A Scalar field has only Magnitude but no direction (e.g. Temperature, Energy, density).
While a Vector field is that, that has both magnitude and direction (e.g. Gravitational field, magnetic field and electric field).

Question 3d(i) What do you understand by the poles of a magnet? Using a magnet of known poles, how can you differentiate between the 2 poles of another magnetic.

Answer 3d(ia) The pole of a magnet is that portion of the magnet where its magnetic attraction appears to be strongest.

Answer 3d(ib) Suspend the magnet of known poles so that it can swing freely. Next bring one pole of the other magnet near this. If they repel each other then they have similar poles while if they attract they are of opposite sign.

Question 3d(ii) The Lines of a magnetic field do not cross, why?

Answer 3d(ii) The line of force of a magnetic field do not cross because the line of force is the line along which a free N pole would tend to move if placed in the field or it is a line such that a tangent to it at any point gives the direction of the field at that point. Therefore if they cross, it means a free N pole will have two directions it can go at the point of crossing but this is not observed.

Question 3d(iii) State three differences between the magnetic properties of steel and soft iron.

Answer 3 d(iii) Differences between the magnetic properties of steel and soft iron.

Soft iron	**Steel**
1. Easily magnetized	1. Not easily demagnetized
2. Demagnetized.	2. Magnetized
3. Have low coercive force	3. Form permanent magnets
4. Have high permeability	4. Have large coercive force
5. Highly purified, annealed and Properly oriented for magnetization in the easy direction	5. Low permeability
6. Form Temporary magnets	6. Impure, strained and contain Grain boundaries

Question 4(a) Name THREE Instruments for detecting radiation from radioactive substances

Answer 4(a) Three instruments for detecting radiation from radioactive substances: - (Any three will do).

1. Geiger – Muller tube/rate meter/Dekatron counter.
2. Ionization chamber
3. Scintillation counter
4. The cloud chamber
5. Solid-state detectors (reversed based semi conductor diode).
6. Spark counter

Question 4 b(i) What do you understand by the term: mass defect

Answer 4 b(i) Mass defect:- when a nuclear reaction takes place we find out that there is a difference in the sum of the masses of the reactants and the sum of the masses of the product. This mass difference shows up in the form of energy liberated during the reaction as $\Delta E = \Delta MC^2$ e.g. $^{238}U \rightarrow \ ^{234}U + \ ^{4}He$

Gives a mass defect of 0.00458U
Iu = 931.5 Mev

$\therefore \Delta E = .00458 \times 931.5$ Mev = 4.3 Mev

The difference between the total mass of an atomic nucleus (proton & neutrons) and the sum of the individual masses is called mass defect.

Question 4 b(ii) What do you understand by the term: Nuclear fusion.

Answer 4 b(ii) Nuclear fusion: this is when the nuclei of the lightest elements are fused together to form a heavier nucleus. It is followed by a release of considerable amount of energy.

e.g. $2_H + 3_H \quad 4_He + 1_n$ Energy
1 1 2 0

Deuterium, Tritium, Helium, Neutron

Question 4b(iii) What do you understand by the term Nuclear binding energy?

Answer 4b(iii) Nuclear binding Energy: this is the amount of energy which would have to be supplied in order to separate the nucleus of an atom against the forces which hold them together. OR it is given by the mass defect for that nuclei multiplied by velocity of height squared
$\Delta E = \Delta MC^2$ (Einstein relation).

OR the work or energy needed to take all the nucleons apart, so that they are completely separated. OR Binding energy = mass diff of nucleus and neutron.

Question 4(c) Give a brief outline of how a nuclear reactor works.

Answer 4(c) U = 235 is bombarded by slow moving neutron. It splits into two smaller elements plus release of large amount of energy. Graphite is placed round the U. To moderate the speed of the neutrons so that chain reaction is prevented from dying out. To control the excess neutron not to get out off hand, neutron absorbing steel rod could be used.

These rods are moved in and out of the reactor which produces a lot of heat, which is sent to the exchange. There it is used to supply heat to the boiler of a stream generator which in turn drives a turbine to produce electricity.

Question 4(d) Give three peaceful uses of nuclear reaction and explain their operations.

Answer 4(d) Peaceful uses of nuclear reaction (Any three)

1. Medical field for radio therapy: This uses radioisotopes which are by products of fission reactions. (e.g. ^{131}I, $^{60}C_0$, ^{192}Ir). After injection into the body their movement through the body organs are monitored.
2. Radioisotopes are used in agriculture as radio active tracers and preservatives.
3. Electricity generation from a Nuclear power plant.
4. For powering space crafts and submarine. Based on small nuclear power reactors.
5. Radiotherapy (medical use) is the use of radioactive emissions to treat patients. The emissions destroy unwanted cells which are present in cancer patients capsules containing some radioactive isotopes (e.g $^{60}C_0$) of appropriate activity and half-life are implanted near the unwanted growth and left there for a carefully calculated time.
6. Radioactive dating to find the age of geological formation or when an archaeological artifact was made. Here carbon dating or uranium dating is used. The isotope of $^{14}{}_{6}C$ has a half-life of 5.76×10^3 years. So this is useful when dating

around 50000 years. For long periods Uranium 238 with a half-life of 4.5×10^9 year is used.

Question 5a(i) Why is it wrong to call a transistor radio just a transistor?

Answer 5a(i) It is wrong to call a transistor radio just a transistor because it comprises of many elements, like transistors, diodes, transformer, resistors, inductors and capacitances.

Question 5a(ii) What are bugging devices? State three merits and demerits of their uses.

Answer 5a(ii) Bugging devices are devices for keeping surveillance of a place, such that conversation there can be monitored. People coming in and out can be monitored as well.

Merits	**Demerit**
Helps to keep security surveillance	Encroaches on people Liberty/rights
Helps to prevent robbery and prevents accident	They are expensive to install/make
Help Police in solving crimes and in preventing it.	They are difficult to maintain

Question 5b(i) How has electronic devices improved the quality of life of Doctors.

Answer 5b (i) Doctors: Electronic devices has helped them in making proper diagnosis of their patients & much faster. (2) it has helped in carrying out delicate operations with great efficiency. (3) it has helped the control and monitoring of recuperating patients particularly those with heart or kidney problems.

Question 5b(ii) How has electronic devices improved the quality of life of the disabled.

Answer 5b(ii) Disabled: Provided them with:

a. Hearing aid.
b. Motorized wheel chairs.
c. Electronically controlled artificial lambs.
d. Electronically controlled cars.

Question 5b(iii) How has electronic devices improved the quality of life of Road traffic controllers

Answer 5b(iii) Road traffic controllers: Helped in

a. Controlling traffic flow at junctions and cross-roads by the operation of traffic lights.
b. Monitoring the number of vehicles plying a particular road.

c. Controlling traffic in an accident area/communicating traffic condition so that they can avoid the area if they can.

Question 5c(i) Compare and contrast 'Solid State' electronic devices with 'Vacuum tube' electronic devices.

Answer 5c(i)

Solid State Devices	Vacuum tube devices
1. Light and portable	1. Heavy and bulky
2. Do not produce too much Heat nor noise	2. Produce lots of heat and noise
3. Can be cheaper to make	3. Expensive to make.
4. Do not require heating elements	4. Requires heating elements
5. Can operate with dry cells of only a few volts	5. Need large power supplies to work
6. Less liable to breakage	6. Very highly prone to breakages

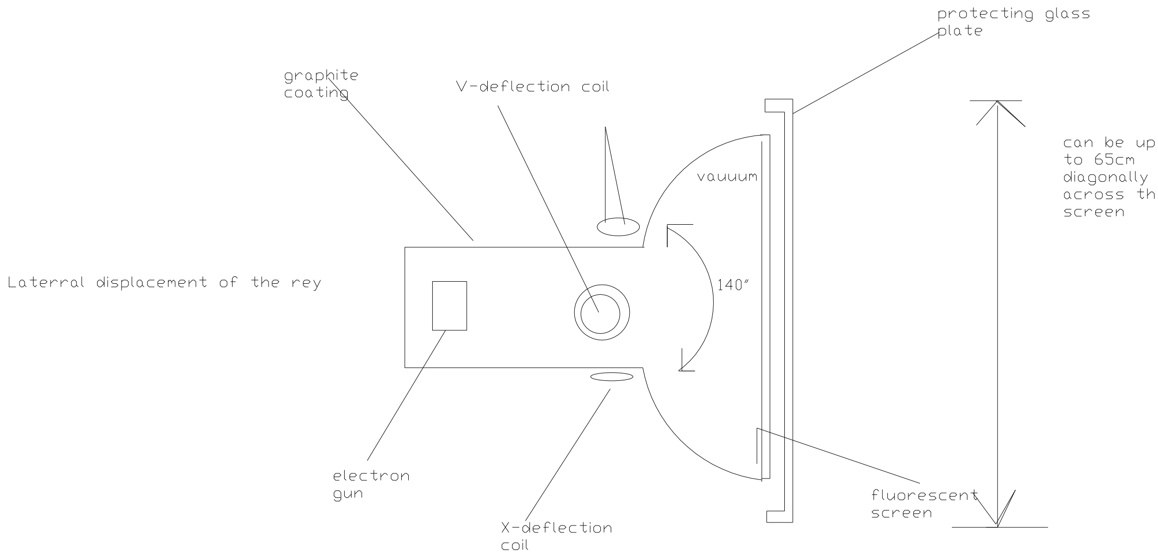
Question 5c(ii) Name THREE equipment that use vacuum tube electronic in homes and explain how one of them work.

Answer 5c(ii) Equipment that use vacuum tube in the homes: (Any three)

1. Television
2. Rectifiers
3. Amplifiers
4. Radio
5. Computer Monitor

[Items 2 to 4 have been completely transistorized nowadays that they may not be seen again in the form of vacuum tube devices in the homes].

T.V. TUBE



This works like the cathode-ray tube to produce picture. In this case the electron beam passing along the tube is deflected using magnetic fields (instead of electrostatic field) produced by two pairs of parallel coils above and below the tube. Magnetic deflection is preferred, rather than electrostatic as much sharper deflection angles can be achieved. The same deflection electrostatically very long tubes would be needed. It uses two time base circuit to trace out the complex patter (RASTER PATTERN). On the TV screen.

The vertical time base moves the spot down the screen at a constant speed every 1/50 second. At the same time the horizontal time base sweeps the spot across the screen forming eye picture lines. The picture lines, a 625 lines in number (British and European) arranged from top to bottom of the screen. Half of these are scanned in the first 1/50 second (odd number lines) and the remaining half is scanned in the next 1/50 sec. (even number lines).

That implies that the picture changes (Refreshed) every 1/50 seconds. The pattern produced appears stable because the human eye can not react fast enough to detect those changes or flickering.

This flicker can at times be seen when a TV programme contains a picture of a TV screen . some dark liens may be seen moving down the TV screen on the picture. This implies that the TV scanning is not in step (or tandem) with the scanning of the camera and a stroboscopic effect is being produced. The modern coloured TV uses three guns (blue green and red guns). The TV screen is coated with phosphorescent dots that are in clusters of threes known as the TRAIDS. The three beams can be steered over the screen to the respective dots. Between the screen and the guns is placed a SHADOW MASK in which regular pattern of holes has been cut. They are so aligned that red gun can only reach red dots, likewise the green and the blue guns respectively. As the beams are traced over the screen they light up the red, green and blue dots in each triad to different level of intensity. The human eye will interpret the triad as a patch of colour, the exact shade and brightness of which is determined by the extent to which the three dots are illuminated.

This is necessary because TV tube has a much bigger screen size than an oscilloscope and to achieve the same deflection; electrostically, very long tubes would be needed.

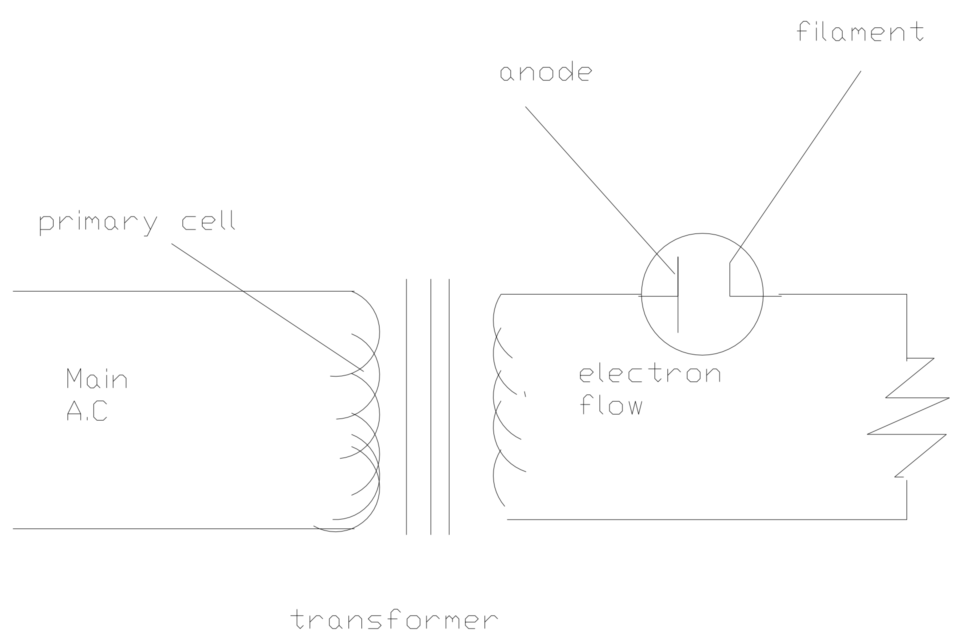
The TV

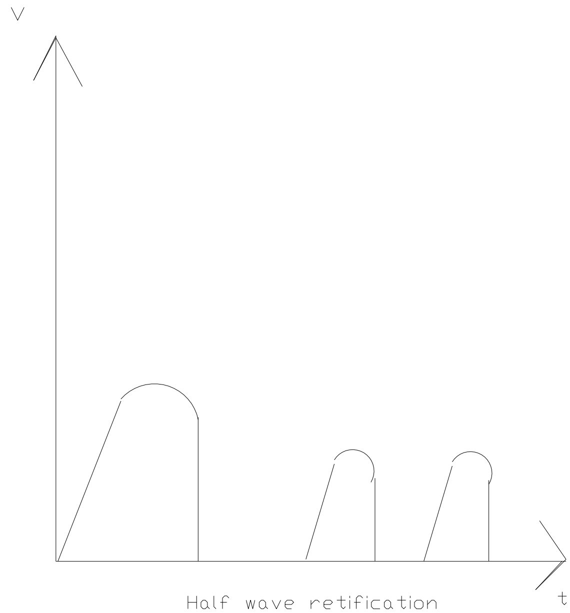
Rays from heated cathode pass through a cylindrical anode to a fluorescent screen. The cathode rays produced light spots on striking the screen. The intensity of the spot is controlled by grids while the direction of the beam is controlled vertically and horizontally by voltage in two pairs of defector plates.

The beam is able to sweep from top to the bottom of the screen and backwards and forwards across the screen rapidly because of the alternating voltage.

When the picture is received by the circuit, the grid voltage varies according to the information received having the spot of light to build up a moving picture on the screen.

Rectifiers





b.

When the A.C. supply is on, electrons are drawn across the valve only on those halves of the secondary voltage cycles when the anode is positive.