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THE UNITED REPUBLIC OF TANZANIA
NATIONAL EXAMINATION COUNCIL
CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

PHYSICS PAPER 1
NOV - 1999

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Data:
Acceleration due to gravity= 10ms^{-2}

$\pi = \frac{22}{7}$

Radius of the earth = 6.4 ×10^{3} km
Distance of the earth from the sum = 1.5 ×10^{8} km

SECTION A

1.Write the letter of the best answer in the answer booklet provided.

(i) Measurement of mass by using equal-arm beam balance uses the principle of
A. conservation of momentum
B. conservation of energy
C. moments
D. gravitational pull of the earth
E. conservation of matter

(ii)The principle of fluid pressure which is used in hydraulic brakes, is the
A. pressure is the same at all levels in a fluid
B. increase of pressure is transmitted equally to all parts of a fluid
C. the pressure at a point in a fluid is due to the weight of the fluid above it
D. increase of pressure can only be transmitted through fluids
E. the pressure at a given depth is proportional to the depth in the fluid

(iii) The surface tension of a fluid is due to
A. molecules on its surface
B. a semi-permeable membrane which covers it
C. the Brownian motion of surface molecules
D. the cohesive force between its surface molecules
E. the adhesive force between molecules of different materials

(iv) Which of the following occurs when more molecules of water return to it than escape from it? A. Evaporation
B. Condensation
C. Diffusion
D. Crystallization
E. Atomization

(v) Given cubical expansivities of mercury and glass are1.8 x 10^{-4}/K and 1.0x10^{-5}/K respectively; a glass vessel of capacity 100 ml holding mercury to the brim, heated trough 100^{0}C will expel mercury of the following volume
A. 18 ml
B. 28 ml
C. 10 ml
D. 8 ml
E. 1.7 ml

(vi) Light waves of a given colour from the sun are allowed to pass through different transparent media. The quantity associated with the wave motion that remains unchanged throughout the path is
A. wavelength
B. velocity
C. frequency

D. amplitude
E. wave energy

(vii) When total internal reflection is just about to occur at an air-water boundary as the incident angle is increased from zero, the refracted ray then

A. travels in water at 90° to the normal
B. travels in air along the normal
C. makes the critical angle with the normal in air
D. travels in the air at an angle less than 90°
E. makes an angle 90° with the incident ray

(viii) Which of the following materials can be used for electromagnet?
A. copper as commutator for a d.c motor
B. soft iron for a core of an electric bell
C. steel for a magnet in a moving coil meter
D. aluminum as slip rings for a.c generator
E. nickel for a magnet in telephone receiver

(ix) A rod of insulating material is charged positively by rubbing against a piece of fabric and the latter is tested for electric charge. The fabric will be expected to have a
A. positive charge equal to that on the rod
B. positive charge less than that on the rod
C. negative charge equal to that on the rod
D. negative charge greater than that on the rod
E. negative charge less than that on the rod.

(x) For resistors connected in parallel the following is true.
A. equivalent resistance is greater than any of the individual resistances
B. equivalent resistance is the sum of individual resistance
C. equivalent resistance is the sum of reciprocals of individual resistances
D. reciprocal of equivalent resistance is the sum of the individual resistance
E. equivalent resistance is always less than either of the resistances

(xi) High voltage is used for transmitting electricity on the National Grid. This is because high voltage.
A. is needed everywhere
B. means high current would be used
C. needs transformers for conversion
D. would minimize electrical energy losses by using low current
E. would facilitate power distribution to customers.

(xii) If A is mass number, Z is atomic number and N is number of neutrons, identity the **incorrect** statements about nuclear decay

A. When gamma (γ) ray emissions occurs A and Z remain unchanged.
B. beta (β) particle emissions are common in nuclei with N greater than Z
C. nuclear decay aims at making Z equal to N
D. nuclei with N greater than Z decay by neutron emission
E. alpha (α) particle decay occurs mainly in heaviest nuclei

(xiii) A transistor is a device which
A. amplifiers alternating current or voltage
B. amplifies current or voltage
C. rectifies current or voltage
D. amplifies and rectifies alternating current or voltage
E. rectifies alternating current or voltage

(xiv) What cause water tides in the sea?
A. Rotation of the earth about the sun
B. Rotation of the moon about the earth
C. Rotation of the earth about its axis
D. Gravitational force due to the earth on the sea
E. Gravitational force due to the moon on the sea

(xv) Which is an **incorrect** statement about the solar planets?
A. they are always moving in space
B. they are all non-luminous
C. they all revolve round the sun as their centers
D. they are all have at least one moon
E. The brightest planet as observed from the earth is Venus.

Section B

2. (a) Using Newton's second law of motion, state two quantities which vary with net force applied on a body.

(b) Write an equation obtained by combining the force and the two quantities you have mentioned.

(c) Evaluate the proportionality constant if your equation is used to define the unit of force, the Newton, while taking a unit of each variable in your equation.

(d) A certain force gives a mass m_1 an acceleration of $12.0 m/s^2$. What acceleration will the same force give two similiar masses when they are joined together?

3. (a) State Boyle's law.

(b) Sketch the graph of pressure (p) against the reciprocal of volume ($^1/_v$) for air at constant temperature.

(c) A bubble of air of volume 50.0mm^3 is released by a diver at a depth where the pressure is 304.0cm Hg. Assuming the temperature remains constant, what is its volume just before it reaches the surface where the pressure is 76.0 cm Hg?

4. (a) Explain what is meant by 'beats' as applied to sound.

(b) Briefly explain how beats are formed.

(c) A vibrating string is sounded with a 288 Hz tuning fork and 3 beats are counted per second. The string is then loaded with small amount of plasticine and 2 beats are counted per second

(i) What is the frequency of the string?
(ii) What is the frequency of the loaded string?

5. (a) Give two differences between a primary and a secondary cell.

(b) Six cells of 2.0V and internal resistance 2.0Ω are connected in two groups of three in series, the two groups are then connected in parallel to an external resistor 30.0Ω

(i) Sketch the arrangement by using conventional electrical symbols.
(ii) Calculate the current which will flow through the external resistor.

6. (a) Name two objects in space which are the earth's nearest neighbours

(b) What are the real names of objects in the sky which are commonly known by the following names?
(i) An evening star
(ii) A morning star
(iii) A shooting star

(c) The earth appears to be stationary, but it is always in motion. Calculate the unnoticed speed of a man along the equator, in km/h,due to
(i). Rotational motion of the earth about its axis
(ii). Revolution of the earth around the sun
Take 1 year = 365 days

Section C

7. (a) State Pascal's principle of transmission of pressure.

(b) A piston of small cross section area of 30.0 cm^2 is used in hydraulic press to exert a force of 300.0N on the enclosed liquid. A connecting pipe leads to a large piston of cross sectional area 600.0cm^2. Find

(i) the force sustained by the larger piston
(ii) the force applied on the smaller piston to support 2.0 tonnes on the larger piston
(iii) the mechanical advantage (MA) of the pistons of the press.

8. (a) (i) Define refractive index of a material

(ii) Explain how the reflective index is related to the velocities in two different adjacent media when refraction of light occurs between them. Hence deduce the relation between refractive index and the wavelengths in the two media.

(b) If the speed of light in air is 3.0 x10^8 m/s and the wavelength,λ ,of yellow light in air is 5.89 x 10^{-7} m, calculate:
(i) the speed, C_s, of yellow light in sulphur of refractive index 1.96.
(ii) the wavelength, λ_s, of yellow light in sulphur of refractive index 1.96.

(c) What causes light to refract when it passes through two adjacent media of different densities (*refractive indices*)?

9. (a) What is meant by magnetic materials? Give two examples.

(b) State the law of magnets.

(c) Explain with an illustration how one can locate the position of a north-pole of a bar magnet.

(d) Explain with an illustration how to magnetize a steel bar using an electric current.

10. (a) (i) Give an account, with diagram, of the structure of a step-down transformer.
(ii) Why is the iron core made of laminations instead of being in one solid piece?

(b) A transformer is used on the 240V a.c supply to deliver 8A at 90 Volts to a heating coil calculate.

(i) the current in the primary winding
(ii) the power in the secondary windings

(c) If the primary current is used to light 25 12V,24W ray lamps what is the efficiency of the transformer?

11. (a) Complete the table below for the three particles which are emitted in a nuclear decay process

Type of particle emitted	Charge on the particle	Position of daughter nuclide in Periodic Table with respect to parent nuclide	Effect on mass number of parent nuclide after emission
Alpha(α)			
Beta (β)			
Gamma (γ)			No effect

(b) Part of a certain nuclear decay series is represented by the following unbalanced equations, in each stage only ONE type of particle is emitted.

(i) $_{90}Th^{232} \rightarrow {}_{88}Ra^{228}$
(ii) $_{88}Ra^{228} \rightarrow {}_{89}Ac^{228}$
(iii) $_{89}Ac^{228} \rightarrow {}_{90}Th^{228}$
(iv) $_{90}Th^{228} \rightarrow {}_{88}Ra^{224}$

identify the type of particle emitted in each of the above stages.

(c) Write two pairs of isotopes from the above series

12.(a) Define the following terms.
(i) Capacitor
(ii) Semi-conductor
(iii) Transistor

(b) What are the differences between a conductor, a semiconductor and an insulator in terms of their conductivity?

(c) An output of transformer is connected in series with semiconductor diode
(i) Draw the sketch of the expected variation of electromotive force against time.
(ii) Give reasons whether this device is suitable or not for use in a radio.

SOLUTIONS SCHEME

SECTION A
(All items in this section to be answered)

Q1 (Multiple choice)
(i) C (moments)
(ii) B (Increases of pressure…)
(iii) D (The Cohesive force…..)
(iv) B (Condensation)
(v) E (1.7 ml)
(vi) C (frequency)
(vii) A (travels in air at 90° to the normal)
(viii) B (soft iron……)
(ix) C (negative charge equal……)
(x) E (equivalent resistance is always less..)
(xi) D (would minimize…….)
(xii) D (nuclei with…..)
(xiii) A (amplifies alternating…..)
(xiv) E (Gravitational force due to the moon on the sea)
(xv) D (They all have at least one moon)

SECTION B
(All questions to be answered)

Q2 (A) According to Newton's second law of motion, the two quantities that determine the net force on an object are:
(i) Mass of object
(ii) Acceleration of the object

(b) The proportionality between force and the two quantities can be expressed as:

$$F \propto ma$$

From this, the equation can be written as:

$$F = kma$$

Where: F is the net force on an object
M is the mass of the object
a is the acceleration of the object
and k is the proportionality constant.

(c) For unit mass, m = 1 kg
and for unit acceleration, a = 1 m/s^2
If one unit of force = 1 Newton = 1N
then by substituting into the equation
F = k m a
1N = k x 1 kg x1 x 1 m/s^2
1N = k x 1 kg m/s^2
= k x 1 kg ms^{-2}
Divide both sides of the equation by 1 $kgms^{-2}$
k = 1 $N/kgms^{-2}$

(d) Data: mass = m_1 kg
acceleration = 12.0 m/s^2

Force = F_1

Required: acceleration = a

when mass = $2m_1$

and Force = F_1

From the given data; using F = ma

$F_1 = m_1 \times 12.0$

But the same force F_1 is used to move twice the mass m_1 so,

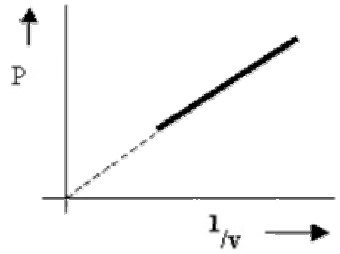
$F_1 = 2m_1 \times a$

So $2 m_1 \times a = m_1 \times 12.0$

$$a = \frac{12.0}{2} = 6.0 \text{ m/s}^2$$

Q3 (a) Boyle's law states that for a given quantity of a gas at constant temperature, the pressure exerted by the gas is inversely proportional to its volume

$P = k (1/v)$ or PV = Constant



(c) Data $V_1 = 50.0 \text{ mm}^3$, $P_1 = 304.0$ cmHg

V_2 = ? (to find), $P_2 = 76.0$ cmHg

Use Boyle's law: PV = Constant

So $P_1V_1 = P_2V_2$

$304.0 \times 50.0 = 76.0 \times V_2$

$V_2 = 304.0 \times 50.0/76.0 = 200.0 \text{mm}^3$

The volume of the bubble just before it reaches the surface will be 200.0mm^3

Q4. (a) When two sources of almost similar frequency are sounded together, you can hear regular rise and fall in loudness of the sound. These are called beats.

(b) Beats are formed when two waves with nearly equal frequencies interfere constructively or destructively at regular intervals.

(c)Data: String frequency = f_s

Loaded string frequency = f_{sl}

Tuning fork frequency = f_t =288 Hz

Beat frequency without loading = 3 Hz

Beat frequency with loading = 2 Hz

Depending upon whether f_s is greater than or less than f_t, the beat frequency can be given by either:

$f_s - f_t = 3\text{Hz}$ (if $f_s > f_t$) ……(1)

or $f_t - f_s = 3\text{HZ}$ (if $fs<f_t$) ……(2)

To find out which equation will apply, we note that when the string is loaded its frequency decreases as per the equation:

$f = (1 / 2l) \sqrt{(T/m)}$,

because loading increases m so f must decrease.

so $f_{sl} < f_s$

(i) The given data shows that beat frequency is reduced when the string is loaded. Only equation (1) shows such a decrease when we substitute values of fs and f_t into equations (1) and (2). So we use equation (1).

$f_s - f_t = 3\text{Hz}$ ……..(1)

Hence $f_s = 3 + f_t = 3 + 288$ Hz

$f_s = 291$ Hz

Frequency of unloaded string = 291 Hz

(ii) Depending upon how much mass is used to load the string, the beat frequency when the string is loaded can be given by either:

$f_{se} - f_t = 2\text{hz}$ (if $f_{se} > f_t$)

Or $f_t - f_{se} = 2\text{Hz}$ (if $f_{se} < ft$)

So $f_{se} = 2 + f_t$ or $f_{se} = f_t - 2$

$= 2 + 288$ or $= 288-2$

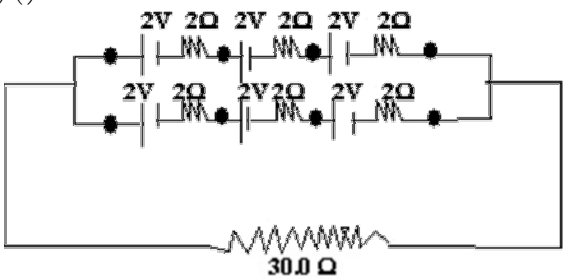
$= 290$ Hz $= 286$ Hz

So frequency of loaded string can be either 290Hz or 286 Hz depending upon the load on the string.

Q5 (a) Differences between primary and Secondary cells:

	Primary Cell	Secondary Cell
1	Chemical reactions that produce e.m.f are not reversible and so the cell cannot be recharged.	Chemical reactions are reversible and the cell can be recharged if required
2	One of the electrodes is eaten away as the cell is used.	The electrodes are altered but return to their original state when recharged

(b) (i) Sketch of the circuit:



(A) Total resistance in 1st branch of cells:

$R_A = 2+2+2 = 6\Omega$

(B) Total resistance in 2nd branch of cells

$R_B = 2+2+2 = 6\Omega$

(C)Equivalent resistance for the two branches of cells

$^1/_{Rc} = {}^1/_{RA} + {}^1/_{RB} = {}^1/_6 + {}^1/_6 = {}^2/_3 = {}^1/_3$

$R_c = 3\Omega$

(D) Total resistance in circuit:

$\underline{R_D = 30+3 = 33\Omega}$

(F) Total e.m.f in 1st branch of cells

$E_F = 2+2+2 = 6V$

(G) Total e.m.f in 2nd branch of cells

$E_G = 2+2+2 = 6V$

(H) Net e.m.f for the two branches connected in parallel:

$\underline{E_H = 6V}$

(I) Current in circuit $= {}^{EH}/_{RD} = {}^6/_{33} = {}^2/_{11}$ Amps

So <u>current in 30 resistor $= {}^2/_{11}$ Amps</u>

Q6 (a) The earth's nearest neighbours in space are (i) Moon and (ii) Venus at inferior conjunction

(b) (i) An evening star is Venus in the evening sky

(ii) A morning star is Venus in the morning sky

(iii) A shooting star is a meteor, which is a streak of light in the night sky which occurs when material from space called a meteoroid enters the atmosphere.

(c) (i) Circumference of earth $= 2\pi r_e$ at the equator

So speed of man at the equator

$$= 2\pi \frac{r_e}{24} km/h$$

$$= \frac{2\times 22\times 6.4\times 10^3}{(7\times 24)} km/h$$

<u>$= 1.68 \times 10^3$ km/h</u>

(ii) Circumference of earth's orbit around the sun $= 2\pi R_o$

So speed of man on earth

$$= \frac{2\pi R_O}{(24\times 365)} km/h$$

$$= \frac{2\times 22\times 1.5\times 10^8}{7\times 24\times 365} km/h$$

<u>$= 1.08 \times 10^5$ km/h</u>

SECTION C

(Any four questions are to be answered)

Q7 (a) Pascal's principle states that pressure exerted at any point on a fluid is transmitted equally in all directions throughout the liquid

(b) (i) $P = \frac{F}{A}$,

Pressure in small piston = Pressure in large piston

$$\frac{300}{30} = \frac{x}{600}$$

$$x = \frac{600\times 300}{30} = 6000 \text{ N}$$

$\therefore$ Force sustained by large piston = 6000 N

(b) (ii) Pressure in small piston = Pressure in large piston

$$\frac{x}{30} = \frac{2000}{600}$$

$$x = \frac{2000\times 30}{6000} = 100 \text{ N}$$

Force applied on small piston to support 2.0 tonnes of weight on large piston = <u>100 N</u>

(iii) M.A. $= \frac{Load}{Effort} = \frac{6000}{300} = 20$

<u>M.A. = 20</u>

Q 8 (a) (i) Refractive index of a transparent material is the ratio of sine of the angle of incidence and the sine of the angles of refraction for a ray of light traveling from vacuum into the material

$$n = \frac{\sin i}{\sin r}$$

(ii) Refractive index of a material can also be expressed as the ratio of the velocity of light in medium to its velocity in another medium

$$n = \frac{V_1}{V_2}$$

But V = f x λ, so $n = \frac{f\times \lambda_1}{f\times \lambda_2}$

and frequency does not change,

So $n = \frac{\lambda_1}{\lambda_2}$

Where λ_1 and λ_2 are the wavelengths of light in 1st and 2nd media respectively.

(b) (i) Assuming speed of light in air and in Vacuum is equal

$$n = \frac{V_{air}}{V_{sulphur}} = \frac{C_a}{C_s}$$

$$1.96 = \frac{3.0\times 10^8}{C_S}$$

$$C_S = \frac{3.0\times10^8}{1.96} = 1.53\times10^8\, m/s$$

(ii) $$n = \frac{\lambda_a}{\lambda_S}$$

$$1.96 = \frac{5.89\times10^{-7}}{\lambda_S}$$

$$\lambda_S = \frac{5.89\times10^{-7}}{1.96} = 3.00\times10^{-7}\, m$$

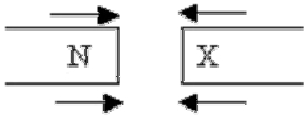
(c) Light refracts (bends) because when the a wave-front of light reaches the boundary between two media, the part of the wave-front that enters the dense medium will travel a shorter distance because speed in a dense medium is slower, compared to the wave-front that is in the less dense medium moves which move further. Hence the wave-front gets bent.

Q9 (a) Magnetic materials are those that can be attracted by a magnet. They are:
iron, cobalt and nickel.

(b) Law of magnets: Like poles repel unlike poles attract.

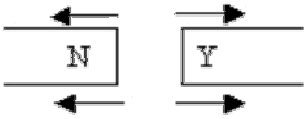
(c) The position of a north pole of a bar magnet can be located by bringing a known north pole near one of the poles.

- If there is attraction then the other pole is the north pole



attraction
X=Southpole

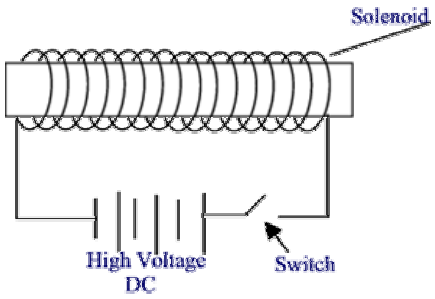
- If there is repulsion, then that pole is north pole



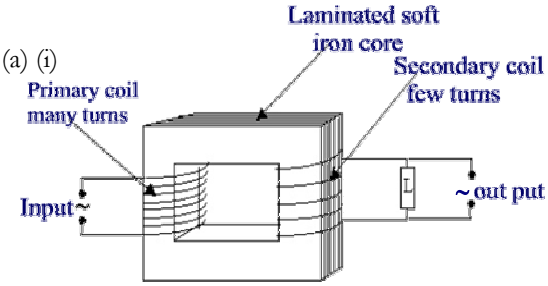
repulsion
y =North pole

Note: If a magnet with known north pole is not available then the bar magnet with the unknown poles can be suspended carefully from its center of gravity using a string or thread. The bar magnet will align itself with the earth's magnetic field. Then the pole that points north will be the north pole.

(d) Place the steel bar inside a solenoid with high current which can produce a high magnetic field. By switching the current on and off regularly the steel bar will become magnetized.



Q10 (a) (i)



A step down transformer consists of a laminated rectangular soft iron ring on opposite arms of which are wound the primary coil with many turns through which the input voltage is fed. On the opposite arm of the laminated soft iron core is wound a secondary coil with fewer turns from which the output with lower voltage is drawn. The wire in the secondary coil should be thicker than that in the primary coil so as to be able to carry the higher current which will flow in the output circuit.

The iron core is made of laminations so as to reduce eddy currents which are induced in the core due to changing magnetic field. Eddy currents can flow easily in a solid block while lamination will break path of flow of current. Laminations also reduce heating of the core because of reduction of eddy currents.

(b) (i) Power in Primary coil = Power in Secondary coil

$240 \times I_p = 90 \times 8$

$$I_p = \frac{90\times8}{240} = 3A$$

So current in primary coil is 3 A

b (ii) Power in Secondary winding
$= V_s \times I_s$
$= 90 \times 8 =$ 720 W

(c) Power consumed by the bulb = Output power of transformer
$= 25 \times 24 = 600W$

$$\text{Efficiency} = \frac{Output Power}{Input Power} = \frac{600W}{720W} = \frac{5}{6} = 0.83$$

Efficiency = 0.83 = 0.83 x 100 % = 83 %

Q 11 (a)

Type of particle emitted	**Charge on the particle**	**Position of daughter nuclide in Periodic Table with respect to parent nuclide**	**Effect on mass number of parent nuclide after emission**
Alpha (α)	2 +ve	2 places lower	Decreases by 4
Beta (β)	1 -ve	1 place above	Negligible effect
Gamma (γ)	No charge	No effect	No effect

(b) (i) α - particle, because the mass number Z has decreased by 4 and the atomic number A decreased by 2

(ii) β- Particles, because Z is unchanged and A has increased by 1

(iii) β- Particles, because Z is unchanged and A has increased by 1

(iv) α - particle, because z has decreased by 4 and A has decreased by 2

(c) The two pairs of isotopes are:

(A) $_{90}Th^{232}$ and $90Th^{228}$
(B) $_{88}Ra^{224}$ and $_{88}Ra^{228}$

Q 12 (a) (i) A capacitor is a device that can store charge

(ii) A semi-conductor is a material which is normally an insulator but becomes a conductor when a certain voltage is applied across it or when it is heated.

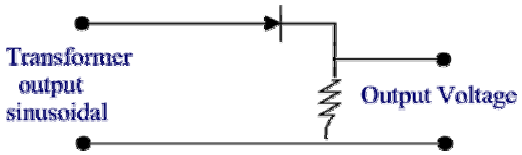
(iii) A transistor is a semiconductor device that can amplify a current or voltage.

(b) Conductor: Has high conductivity that decreases with temperature.

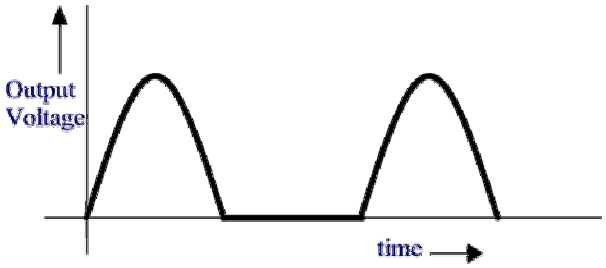
Semiconductor: Has very low conductivity at normal temperatures but the conductivity increases above a certain temperature or above a certain electric field.

Insulator: Always has very low conductivity except when very high voltage is applied.

(c) (i) For a sinusoidal input in the primary coil of the transformer whose output is connected to a semiconductor diode through a resistance as follows:



the output will be as follows:



(ii) The semiconductor diode, when connected as above is not suitable for use in a radio because the output is intermittent and hence will introduce interference in the radio signal.