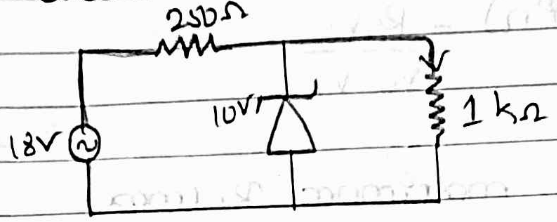
1) Find the zener current and power dissipation across zener diode.



Given :- $V_S = 18V$ $R_S = 250\Omega$ $V_Z = 10V$ $R_L = 1k\Omega$

$I_Z = ?$ $P_Z = ?$

Formula :- (i) zener current $I_Z = I_S - I_L$

But $I_L = \frac{V_Z}{R_L} = \frac{10V}{1k\Omega} = 10mA$

& $I_S = \frac{V_S - V_Z}{R_S}$

$I_S = \frac{18V - 10V}{250\Omega}$

$I_S = 32mA$

Zener current $I_Z = I_S - I_L$

$I_Z = 32mA - 10mA$

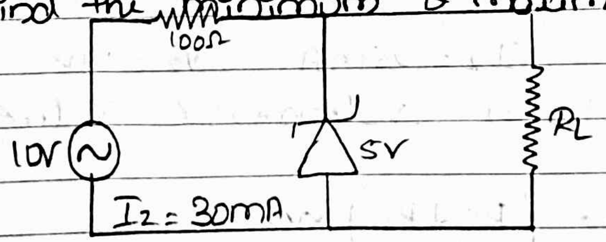
$\boxed{I_Z = 22mA}$

ii) Power dissipation, $P_Z = I_Z \times V_Z$

$P_Z = 22mA \times 10V$

$\boxed{P_Z = 220mW}$

2) Find the minimum & maximum value of R_L



Given :-

$V_S = 10V$ $R_L(max) = ?$

$I_Z = 30mA$ $R_L(min) = ?$

$R_S = 100\Omega$

$V_Z = 5V$

Formula:- $R_L(max) = \frac{V_Z}{I_L}$

$R_L(min) = \frac{R_S V_Z}{V_S - V_Z}$

(1) Load resistance maximum $R_L(max)$

$R_L(max) = \frac{V_Z}{I_L} = 5V$

$I_S = \frac{V_S - V_Z}{R_S} = \frac{10-5}{100} = 50mA$

$I_Z = 30mA$ $\quad I_L = I_S - I_Z = 20mA$

$R_L(max) = V_Z / I_L = \frac{5V}{20mA} = 250\Omega$

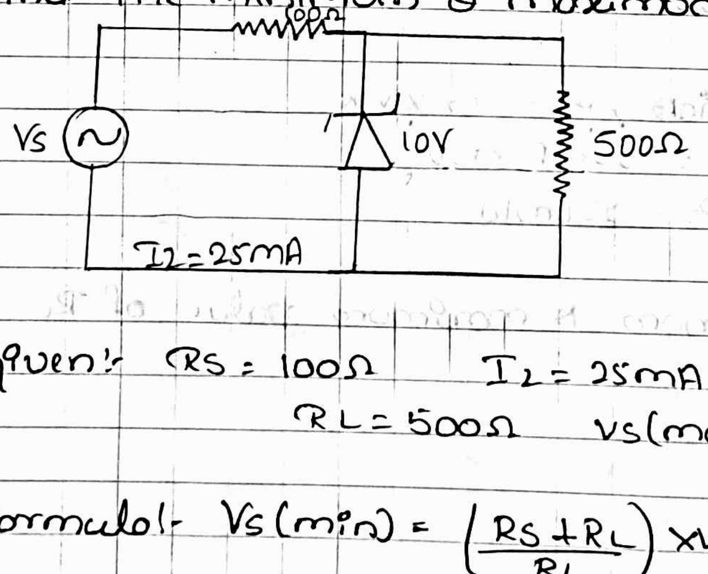
$\boxed{R_L(max) = 250\Omega}$

(2) Load resistance minimum $R_L(min)$

$R_L(min) = \frac{R_S V_Z}{V_S - V_Z} = \frac{100 \times 5}{10-5}$

$\boxed{R_L(min) = 100\Omega}$

3) Find the minimum & maximum value of Vs



Given:- $R_S = 100\Omega$ $\quad I_Z = 25mA$ $\quad V_Z = 10V$

$R_L = 500\Omega$ $\quad V_S(max) = ?$ $\quad V_S(min) = ?$

Formula:- $V_S(min) = \left(\frac{R_S + R_L}{R_L}\right) \times V_Z$

$V_S(max) = I_S \times R_S + V_Z$

(1) Source voltage minimum $V_S(min)$

$V_S(min) = \left(\frac{R_S + R_L}{R_L}\right) V_Z$

$$= \left(\frac{100+500}{500}\right) \times 10$$

$$= \frac{600 \times 10}{500} = 12V$$

$$\boxed{V_S(min) = 12V}$$

(2) Source voltage maximum $V_S(max)$

$$V_S(max) = I_S \times R_S + V_2$$

$$I_L = \frac{V_2}{R_L} = \frac{10V}{500\Omega} = 200mA$$

$$I_Z = 200mA$$

$$I_S = I_Z + I_L = 25 + 20 = 45mA$$

$$V_S(max) = I_S R_S + V_2$$

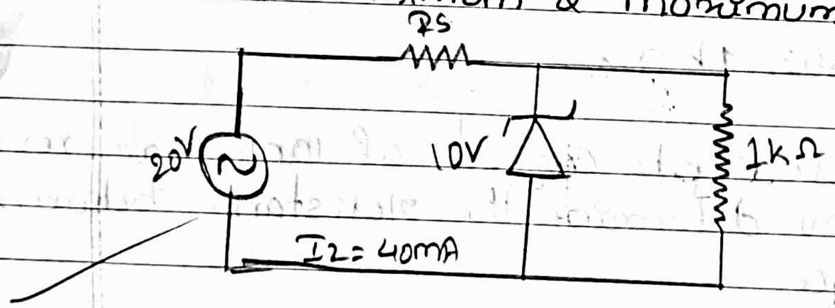
$$= 45mA + 100\Omega + 10V$$

$$= 4500mV + 10V$$

$$= 4.5V + 10V$$

$$\boxed{V_S(max) = 14.5V}$$

(4) Find the minimum & maximum value of R_S



Given :- $V_S = 20V$, $V_Z = 10V$, $I_Z = 40mA$, $R_L = 1k\Omega$, $R_S(min) = ?$, $R_S(max) = ?$

Formula :- $R_S(min) = \frac{V_S - V_Z}{I_S}$

$$R_S(max) = \frac{R_L(V_S - V_Z)}{V_Z}$$

(1) source resistance minimum $R_S(min)$.

$$I_L = \frac{V_Z}{R_L} = \frac{10V}{1k\Omega} = 100mA$$

$$I_Z = 40mA$$

$$I_S = I_Z + I_L = 40+10 = 50mA$$

$$R_S(min) = \frac{V_S - V_Z}{I_S} = \frac{20-10}{50mA}$$

$$\boxed{R_S(min) = 200\Omega}$$

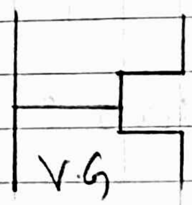
(2) source resistance maximum $R_S(max)$

$$R_S(max) = \frac{R_L(V_S - V_Z)}{V_Z}$$

$$= \frac{1k\Omega\,(20-10)}{10}$$

$$\boxed{R_S(max) = 1k\Omega}$$

5) JFET Produces a gate current of 10nA gate reverse biased with 10V determine the resistance between gate & source



Given that :- $I_G = 10nA$

$V_{GS} = 10V$

$R_{GS} = ?$

$$V_{GS} = I_G R_{GS}$$

$$R_{GS} = \frac{V_{GS}}{I_G}$$

$$= \frac{10V}{10 \times 10^{-9} A}$$

$$R_{GS} = 10^9 \Omega$$

6) Given that $I_{DGS} = 10mA$ $V_p = 4V$ (kirchoff's v.L)
Calculate I_D when the cases are
(i) $V_{GS} = 0V$ ii) $V_{GS} = -1.5V$ iii) $V_{GS} = -4V$

Given that :- $I_{DGS} = 10mA$, $V_p = 4V$

$$I_D = I_{DSS}\left[1 - \frac{V_{GS}}{-V_p}\right]^2$$

(i) $V_{GS} = 0V$

$$I_D = 10mA\left[1 - \frac{0}{-4V}\right]^2$$

$$I_D = 10mA[1-0]^2$$

$$I_D = 10mA$$

ii) $V_{GS} = -1.5V$

$$I_D = 10mA\left[1 - \frac{-1.5V}{-4V}\right]^2$$

$$I_D = 10mA\left[1 - \frac{1.5}{4}\right]^2$$

$$I_D = 3.9mA$$

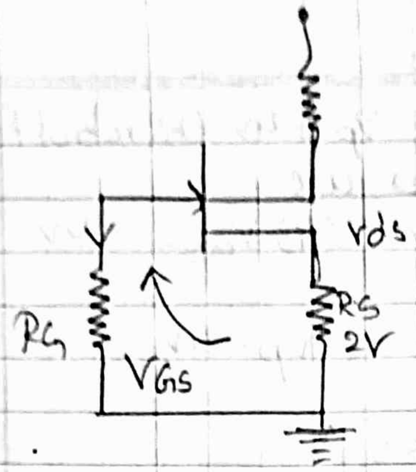
(iii) $V_{GS} = -4V$

$$I_D = 10mA\left[1 - \frac{-4V}{-4V}\right]^2$$

$$= 10mA[1-0]^2$$

$$I_D = 0mA$$

3)



$I_{DSS} = 10mA$
$V_p = -3V$
Find I_D & V_{DS}
$V_s = 2V$
V_D:

Given that:-

$$I_D = I_{DSS}\left[1 - \frac{V_{GS}}{-V_P}\right]^2$$

According to KVL

$V_{GS} + V_S + (I_G R_G)$ | $\because I_G = 0.$
$V_{GS} + V_S + (0.R_G) = 0.$
$V_{GS} \pm 2V = 0$
$V_{GS} = -2V$

$$I_D = 10mA\left[1 - \frac{-2V}{-3V}\right]^2$$

$$= 10mA\left[1 + 2/3\right]^2$$

$I_D = 27.7mA.$

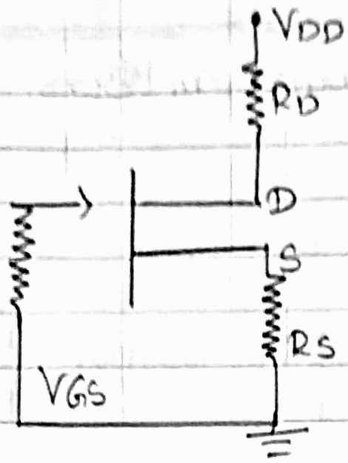
$V_D = V_{DD} - R_D I_D$
$V_D = 15V - [3k\Omega \times 27.7mA]$
$V_D = 15V - [3 \times 27.7]$
$V_D = 15 - 83.1$
$V_D = -68.1V$

$V_{DS} = V_D - V_S$

$= -68.1V - 2$

$V_{DS} = -70.1V$

4)



$I_{DSS} = 5mA$

$V_P = -4V$

$I_D = 2mA$

$V_{GS} = ?$

Solution:-

$$I_D = I_{DSS}\left[1 - \frac{V_{GS}}{-V_P}\right]^2$$

$$2mA = 5mA\left[1 - \frac{V_{GS}}{+4V}\right]^2$$

$$\frac{2mA}{5mA} = \left[1 - \frac{V_{GS}}{4}\right]^2$$

$$0.4 = \left[1 - \frac{V_{GS}}{4}\right]^2$$

$$\sqrt{0.4} = 1 - \frac{V_{GS}}{4}$$

$$0.63 - 1 = \frac{-V_{GS}}{4}$$

$$1 - 0.37 = \frac{+V_{GS}}{4}$$

$$0.37 = \frac{V_{GS}}{4}$$

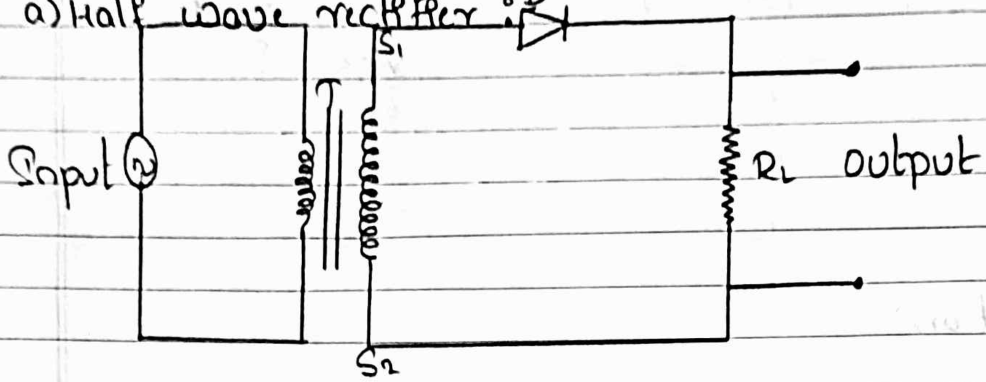
$$0.37 \times 4 = V_{GS}$$

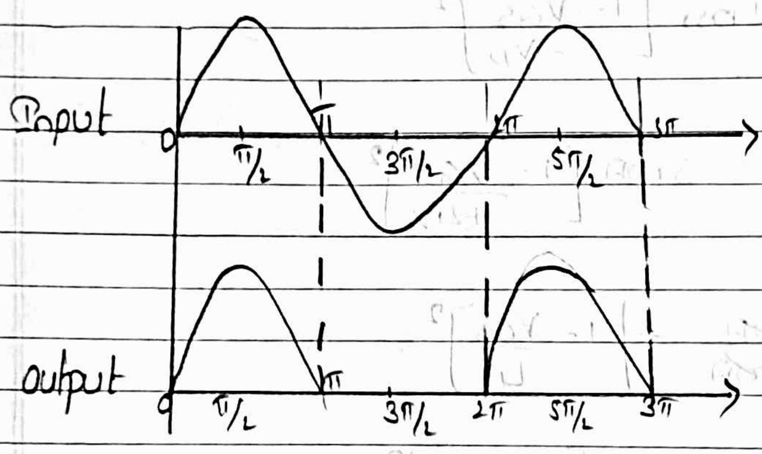
$$1.48 = V_{GS}.$$

$$V_{GS} = 1.48V.$$

1) Explain half wave and full wave rectifiers.

a) Half wave rectifier :-



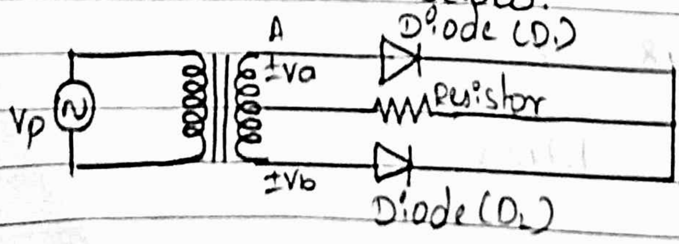


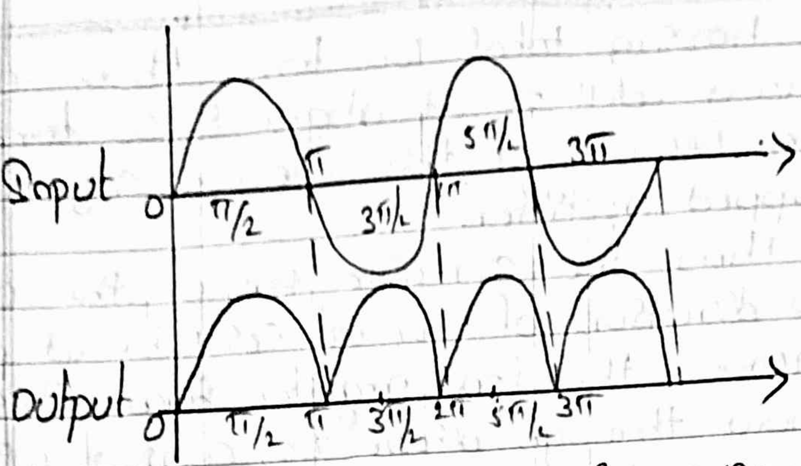
We are given AC signal to rectifier circuit, Consider for the positive half cycle, for the positive half cycle S_1 becomes positive and S_2 becomes negative. since S_1 is positive then diode will be at forward bias, current passes through the diode.

For the negative half cycle, S_1 becomes negative & S_2 becomes positive then since S_1 is negative diode said to be in reversed bias, then current does not pass through diode. Then no wave form will be found for this cycle.

b) Full wave rectifier :-

Circuit diagram of full wave rectifier will be given below.



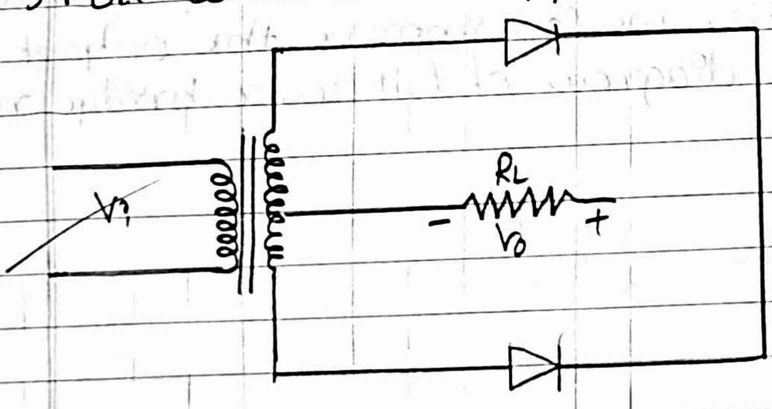


we are given AC signal to rectifier circuite. Consider positive half cycle, for this diode D_1 becomes forward bias & diode D_2 becomes reversed bias. Current passes through diode D_1, positive output wave form will be get.

For the negative half cycle diode D_1 is of reversed bias & diode D_2 will be at forward bias. current will be passes through diode D_2. This case also we are geting output positive wave form.

2) Explain two types of full wave rectifier.
1) Full wave centre tapped rectifier
2) Full wave bridge rectifier.

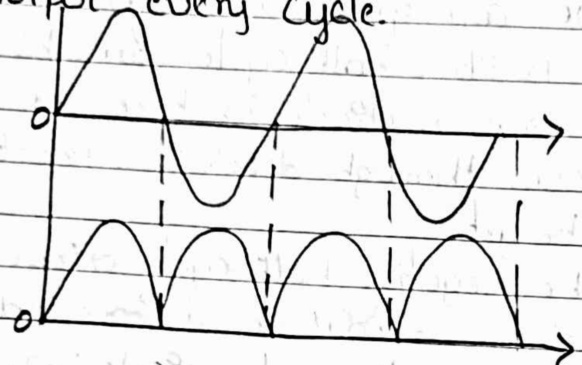
1) Full wave centre tapped rectifier.



Centre tapped rectifier is 1 type of full wave bridge rectifier.

In the above circuite we have primary coil & secondary coil. In the secondary coil. we can see the centre tapped structure. Tapping will be exactly at the centre. we can see the secondary side of the transformer having total 100 terns then after taping 50 terms will be at above & 50 terms will be below side. Because of this we can say circuit is centre tapped rectifier.

Then the circuite passes the current through D_1 & direction of current will be at positive to negative across the load register. Again this process will be continued through diode D_2. current will get at output every cycle.



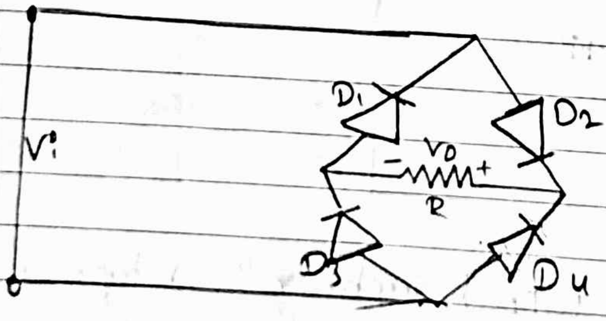
According to kirchoff's voltage law for both cycles (positive & negative).

$$+V_i - V_o = 0$$

$$V_o = V_i$$

b) Full wave bridge rectifier :-

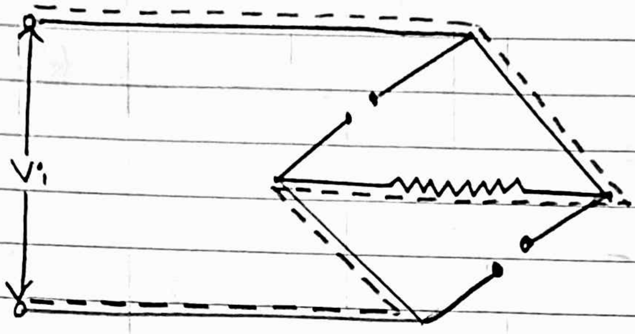
we need full wave rectifier, by using full wave rectifier we can improve the output dc voltage. circuit diagram of full wave bridge rectifier is given below.



For the positive half cycle, diode D_2 and diode D_3 are the forward biased and diodes D_1 & D_4 are in reveresed bias.

Consider the 4 diodes are ideal then we

can replace diodes D_2 & D_3 as short circuit & diodes D_1 & D_4 as closed circuit.



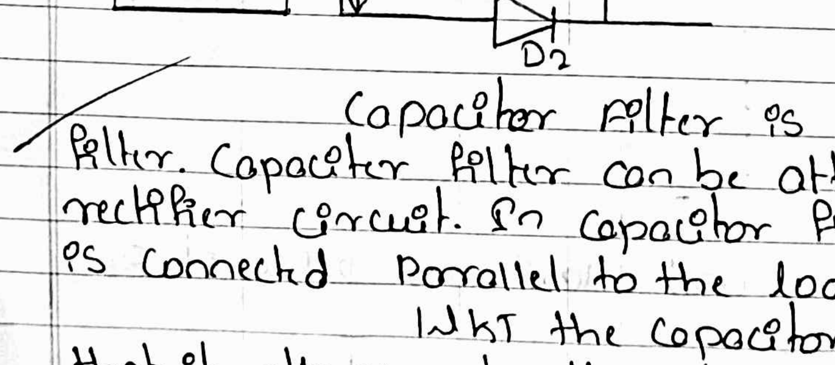
The direction of current will be denoted as doted line. At V_o the current direction will be positive to negative.

According to KVL $+V_i - V_o = 0$

$$\boxed{V_i = V_o}$$

3) Capacitor filter & Inductor filter briefly explain.

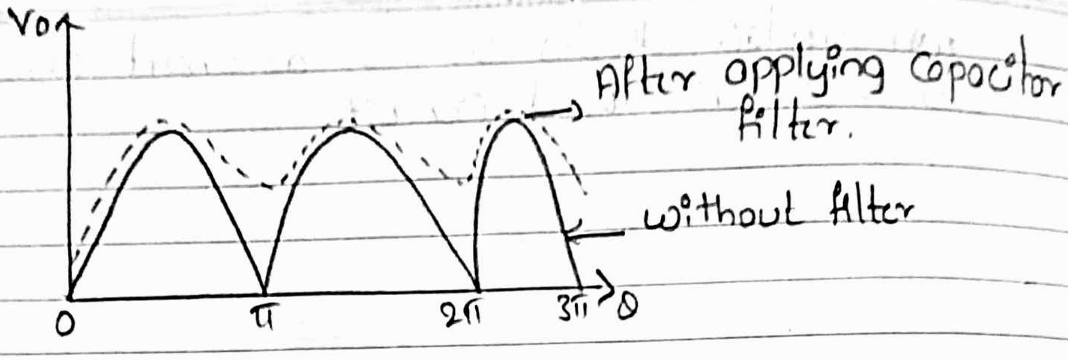
a) Capacitor filter.



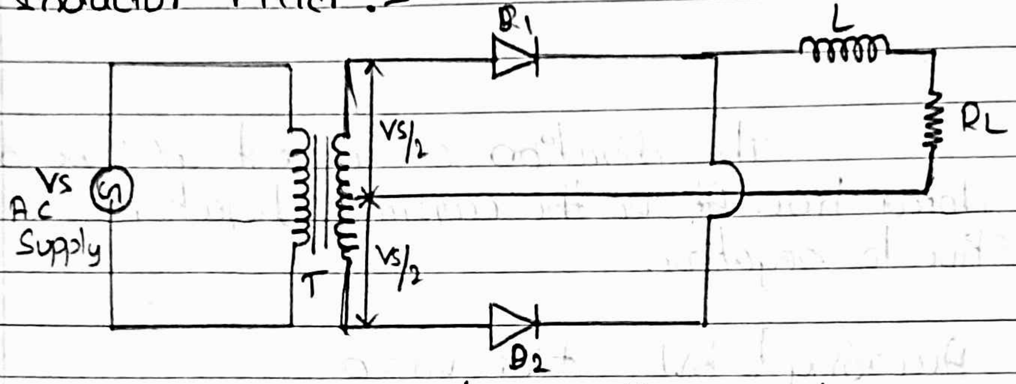
Capacitor filter is one of the type of filter. Capacitor filter can be attached in front of rectifier circuit. In capacitor filter the capacitor is connected parallel to the load resistor.

WKT the capacitor have a property that it allows only alternating current. It doesn't allow direct current through it.

Capacitor filter is converted pulsating dc to pure dc. The output wave form will be as given below.

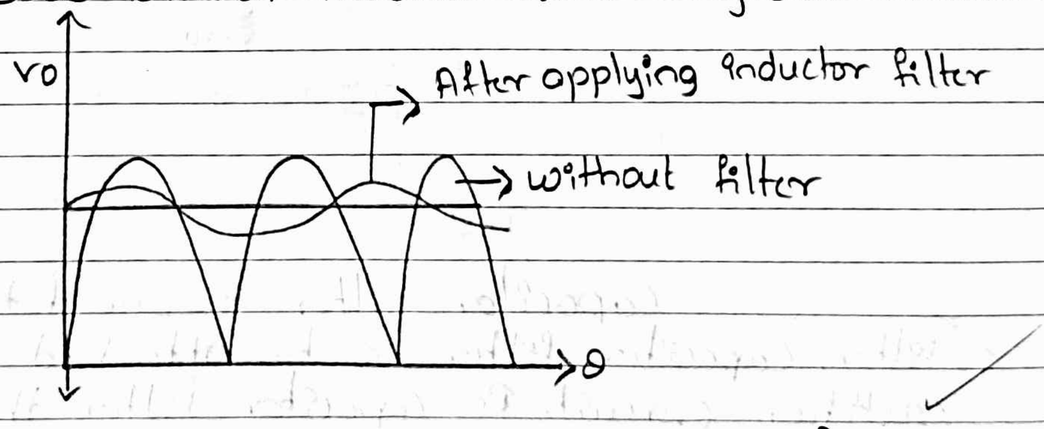


2) Inductor Filter :-

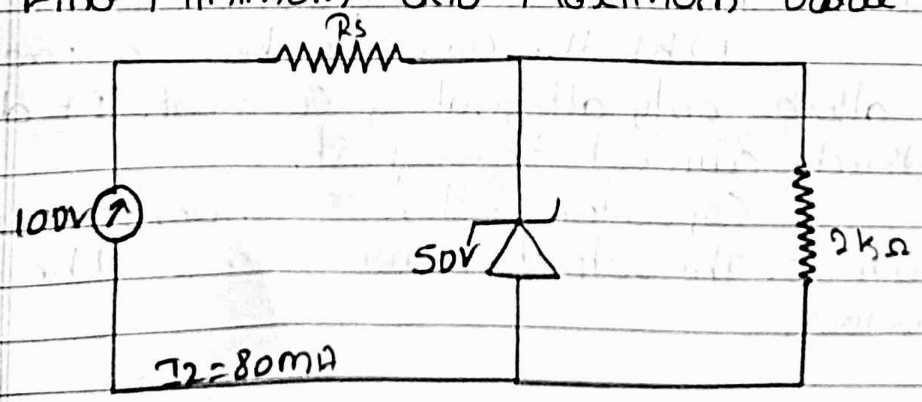


Inductor filter is also one of the type of filter. Inductor filter is attached in front of rectifier circuit. In inductor filter inductor L is connected in series with the load resistor.

Inductor have a property that it allows only direct current but not alternating current. The wave form of inductor filter is given below.



4) Find Minimum and Maximum value of Rs



Given :- $V_s = 100V$ $R_L = 2k\Omega$

$V_2 = 50V$ $R_s(max) = ?$

$I_2 = 80mA$ $R_s(min) = ?$

Formula:-

$$R_s(min) = \frac{V_s - V_2}{I_s} \qquad R_s(max) = \frac{R_L(V_s - V_2)}{V_2}$$

(i) Source resistance minimum $R_s(min)$

$$I_L = \frac{V_2}{R_L} = \frac{50}{2} = 25mA$$

$$I_2 = 80mA$$

$$I_s = I_2 + I_L$$
$$= 80 + 25$$
$$I_s = 105mA$$

$$R_s(min) = \frac{V_s - V_2}{I_s}$$

$$= \frac{100 - 50}{105}$$

$R_s(min) =$ Ω

ii) Source resistance maximum $R_s(max)$

$$R_s(max) = \frac{R_L(V_s - V_2)}{V_2}$$

$$= \frac{2k\Omega(100V - 50V)}{50V}$$

$$= \frac{2k\Omega(\cancel{50})}{\cancel{50}}$$

$R_s(max) = 2k\Omega$

1) A surface ammount of gas at NTP is expanded to 3 times it's volume under adiabatic conditions calculate the resulting temperature and pressure if γ for the gas is 1.40

Solution:- $V_2/V_1 = 3$, $T_1 = 273K$, $P_1 = 1atms$, and $\gamma = 1.40$

Required : T_2 & P_2

from TV relation

$T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1}$

$T_2 = T_1 \left(\frac{V_1}{V_2}\right)^{\gamma-1} = 273 \times \left(\frac{1}{3}\right)^{1.40}$

$= 176K$

$= -97°c$

from the relation

$P_1 V_1^{\gamma} = P_2 V_2^{\gamma}$

$P_2 = P_1 \left(V_1/V_2\right)^{\gamma}$

$= 1 \times (1/3)^{1.40}$

$= 0.2148$ atm.

260' 10/10

Problems

1. Green light of wavelength 5700 A° from a Narrow slit is incident on a double slit If overall separation of 10 fringe-s on a sreen 200 cm an way is 2cm find slit separation.

Given $\lambda = 5700 A^0 = 5700 \times 10^{-10} m$

$10\beta = 2cm$

$= 2 \times 10^{-2} m$ $\quad 1B = \frac{2\times10^{-2}}{10}$

$B = 0.2 \times 10^{-2} m$

$d = ?$ $\quad d = \frac{\lambda D}{B}$

$d = \frac{5700 \times 10^{-10} \times 2}{0.2 \times 10^{-2}}$

$= 5.7 \times 10^{-4}$

slit separation $= 57 \times 10^{-5} m$

2. Interfere fringes are formed by biprism whose acute angle is 20° refractive index is 1.5 slit distance from biprism is 10 cm and is illuminated by light of wavelength 6000A° find the fringe width on a screen placed at a distance of 1 m from the biprism

$\lambda = 6000 A^0$ $\quad$ angle 20 $\quad \mu = 1.5$ $\quad \frac{20}{60} \times \frac{\pi}{180} = \frac{\pi}{3 \times 180}$

$a = 0.1 m$ $\quad \alpha = 0.0058$ radian $\quad = 0.0058$ radian

$d = 2a(\mu - 1)\alpha$

$= 2 \times 0.1 (1.5 - 1) 0.0058$

$= 2 \times 0.1 \times 0.0058 \times 0.5$

$= 0.0016 \times 0.5$

$= 0.00058 m$

$B = \frac{\lambda D}{d} = \frac{6000 \times 10^{-10} \times 1}{0.00058}$

$= \frac{6 \times 10^{-2}}{58}$

$= 1.03 \times 10^{-3} m$

3> In Biprism experiment interference fringes are produced in the focal plane of the eye piece at a distance of 1m from the slit A lens insuted between the biprism

3> at the eye piece produces two virtual images of the slit 4.05 mm apart in one position of the lens & 2.90 mm apart in another If the wavelength of light used is 589.3 nm find the fringe width.

$d_1 = 4.05\ mm \qquad d_2 = 2.90\ mm$

$\lambda = 589.3\ nm = 589.3 \times 10^{-9} m$

$d = \sqrt{d_1 d_2}$

$d = \sqrt{4.05 \times 10^{-3} \times 2.9 \times 10^{-3}}$

$d = 10^{-3} \sqrt{4.05 \times 2.9}$

$d = 10^{-3} \sqrt{11.745}$

$d = 3.42 \times 10^{-3}\ m$

$\beta = \frac{\lambda D}{d} = \frac{589.3 \times 10^{-9}}{3.42 \times 10^{-3}} = 172.30 \times 10^{-6}$

The fringe width is $= 0.17 \times 10^{-3}\ m$

4. In a Biprism experiment the eye piece was placed at a distance of 120 cm from the source The distance between two virtual sources was find to be 0.075 cm find the wavelength of light of the source if the eye piece has to be moved ~~motion~~ cross through a distance 1.888 for 20 fringes to cross the field of view

$D = 120 \times 10^{-2}\ m$

$d = 0.075\ cm \qquad \lambda = ?$

$20\ \beta = 1.888 \times 10^{-2} m$

$I\beta = \frac{1.888 \times 10^{-2}}{20}$

$= 0.0944 m$

$\lambda = \frac{0.0944 \times 0.075 \times 10^{-2} \times 10^{-2}}{180 \times 10^{-2}}$

$= \frac{0.00708 \times 10^{-2} \times 10^{-2}}{120 \times 10^{-2}}$

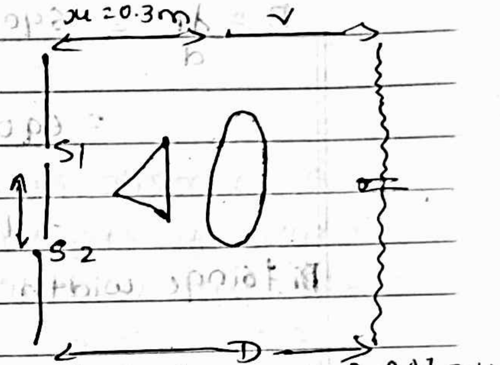
$= \frac{0.00708 \times 10^{-2} \times 10^{-2}}{120 \times 10^{-2}}$

$= 59 \times 10^{-8}\ m$

$= 590\ nm$

wavelength of light is 590 nm

5) In an experiment with Fresnel's biprism bands 1.96 cm in width are observed at a distance of 1 m from the slit. The convex lens then put between the prism and the eye piece so as to give the image of the sources of the distance of 1 m from the slit. This distance apart of the images is found to be 0.007 m. The lens being 0.3 m from the slit calculate wavelength of light.



$D = 1m$

$\beta = 1.96 \times 10^{-3} m$

$d = 3 \times 10^{-3}$

$\beta = \frac{\lambda D}{d}$

$\lambda = \frac{\beta d}{D}$

$= \frac{1.96 \times 10^{-3} \times 3 \times 10^{-3}}{1}$

$= 5.88 \times 10^{-6} m$

$= 5880 \times 10^{-9} m$

mag'n' $\frac{v}{u} = \frac{v}{0.03} = \frac{d_1}{d}$

$\frac{v}{0.3} = \frac{d_1}{d}$

$d = \frac{d_1 \times 0.3}{v} = \frac{0.007 \times 0.3}{0.7}$

$= 3 \times 10^{-3}$

6. Interference fringes formed on a screen 1.2 m from double slit of width 0.45 mm are measurement to be 1.5 mm apart find the wavelength of light used

$D = 1.2 m$ $\quad d = 0.45 \times 10^{-3} m$ $\quad \beta = 1.5 \times 10^{-3} m$

$\lambda = \frac{\beta d}{D}$

$= \frac{1.5 \times 10^{-3} \times 0.45 \times 10^{-3}}{1.2}$

$= 0.5625 \times 10^{-6} m$

$= 56.25 \times 10^{-8} m$

7. Interference fringes are observed with a biprism of refracting angle 1° and refractive index 1.5 on a screen 80 cm away from it. If the distance between source and the biprism is 20 cm calculate the fringe

width when the wave length of light used is 6900 A°

$a = 0.2\ m \quad D = 0.8\ m \quad 1° = \frac{\pi}{180} = 0.0174$ radian

$d = 2a(\mu - 1)\alpha$

$d = 2(0.2)(1.5 - 1) \times 0.0174$

$d = 0.2 \times 0.174$

$d = 0.00348\ m$

$B = \frac{\lambda D}{d} = \frac{6900 \times 10^{-10} \times 0.8}{0.00348}$

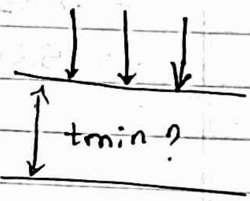
$= \frac{690 \times 10^{-10} \times 0.8 \times 10^{5}}{348}$

$= 15.86 \times 10^{-5}$

Bi fringe width $= 0.2 \times 10^{-3}\ m$

8. A parallel beam of light of wavelength 5890×10^{-8} cm is incident on a thin glass slit normally calculate the smallest thickness of the glass plate which will appear dark by reflection

Given



$\lambda = 5890 \times 10^{-8}$ cm

$\lambda = 5890 \times 10^{-10} m$

The film will appear dark if

$\Delta a = 2\mu t \cos r = m\lambda$

For minimum thickness $m = 1$

$\therefore 2\mu t \cos r = 1 \times 5890 \times 10^{-10}$

taking $\mu = 1.5$

$t_{min} = \frac{m\lambda}{2\mu}$

$= \frac{1 \times 5890 \times 10^{-10}}{2 \times 1.5}$

$= 1963.33 \times 10^{-10} m$

$= 0.196\ \mu m$

If the film has to appear bright by reflected light

$\Delta = 2\mu t \cos r = (2m+1)\frac{\lambda}{2}$

$$t_{min} = \frac{(2m+1)\frac{\lambda}{2}}{2\mu\cos r}$$

$$t_{min} = \frac{\lambda}{4\mu}$$

$$= \frac{5890 \times 10^{-10}}{4 \times 1.5}$$

$$= 981.66 \times 10^{-10}$$

$$= 0.0981\ \mu m$$

9. A soap film of 4×10^{-7} m thick is observed a 50° to the normal find the wavelength of light in the visible spectrum which will be absent from the reflected light (Refractive index $\mu = 4/3$)

Those wavelength which satisfy

$\Delta = 2\mu t \cos r = m\lambda$

are absent from the reflected light

For $m = 1$

$\lambda_1 = 2 \times \frac{4}{3} \times 4 \times 10^{-7} \times 0.82$

$= 874.7 nm$

For $m = 2$

$\lambda_2 = \frac{1}{2} \times \lambda_1 = 437.3\ nm$

For $= m = 3$

$\lambda_3 = \frac{1}{3} \times \lambda_1 = 291.56\ nm$

10. A parallel beam of sodium light of wavelength 5890×10^{-10} m is incident on a thin film of refractive index 1.3 such that the angle of refraction into the film is 60° Find the smallest thickness of the film that makes the film appear dark by reflection

$\lambda = 5890 \times 10^{-10} m$

$2\mu t \cos r = m\lambda$

$$t = \frac{m\lambda}{2\mu\cos r}$$

$$= \frac{m\lambda}{2\mu\cos r} = \frac{5890 \times 10^{-10} \times 2}{2 \times 1.3} = 4530.76 \times 10^{-10}$$

$t_{min} = 0.45\ \mu m$

$= \cancel{4.780}$

Q.NO. 1

1. Define waves :- A wave can be described as a disturbance that travels through a medium from one location to another location without transporting matter.

2. Beats :- The two waves having similar amplitude but slight difference in their frequencies super impose on each other they produces beats".

Q.NO. 2.

1) (Analytic treatment of Beats (waxing and wanning)

Consider two waves in terms of time and wavelength

$$y_1 = a\sin\left[2\pi\left(n_1 t - \frac{x}{\lambda_1}\right)\right]$$

$$y_2 = a\sin\left[2\pi\left(n_2 t - \frac{x}{\lambda_2}\right)\right]$$

consider, a listener beat $x=0$

$$y_1 = a\sin 2\pi n_1 t$$

$$y_2 = a\sin 2\pi n_2 t$$

Applying super position principle

$$y = x_1 + x_2$$

$$y = a\sin 2\pi n_1 t + a\sin 2\pi n_2 t$$

$$y = a[\sin(2\pi n_1 t) + \sin(2\pi n_2 t)]$$

We know that

$$\sin C + \sin D = 2\sin\left[\frac{C+D}{2}\right]\cos\left(\frac{C-D}{2}\right)$$

$$y = a\left[2\sin 2\pi t\left(\frac{n_1+n_2}{2}\right)\cos 2\pi t\left(\frac{n_1-n_2}{2}\right)\right]$$

$$y = 2a\cos 2\pi t\left(\frac{n_1-n_2}{2}\right)\sin 2\pi t\left(\frac{n_1+n_2}{2}\right)$$

put, $A = 2a\cos 2\pi t\left(\frac{n_1-n_2}{2}\right)$

& $n = \frac{n_1+n_2}{2}$

$\langle y = A\sin 2\pi n t\rangle$

The above equation is a wave equation of amplitude (A) & frequency (n)

1) For maximum Amplitude [waxing].

$A = \pm 2a$

$2a \cos 2\pi t \left(\frac{n_1 - n_2}{2}\right) = \pm 2a$

$2a \cos 2\pi t \left(\frac{n_1 - n_2}{2}\right) = \pm 2a$

$\cos 2\pi t \left(\frac{n_1 - n_2}{2}\right) = \pm 1$

$\cos \pi t \,(n_1 - n_2) = \pm 1$

$\pi t\,(n_1 - n_2) = 0, \pi, 2\pi, 3\pi \ldots$

$t = 0, \frac{1}{(n_1 - n_2)}, \frac{2}{(n_1 - n_2)}, \frac{3}{(n_1 - n_2)} \ldots$

Time period $T = \frac{1}{(n_1 - n_2)}$

frequency $f = (n_1 - n_2)$

2) For minimum Amplitude [waning]

$A = 0$

$2a \cos 2\pi t \left(\frac{n_1 - n_2}{2}\right) = 0$

$\cos 2\pi t \left[\frac{n_1 - n_2}{2}\right] = 0$

$\cos \pi t\,(n_1 - n_2) = 0$

$\pi t\,(n_1 - n_2) = \pi/2, 3\pi/2, 5\pi/2 \ldots$

$t = \frac{1}{2(n_1 - n_2)}, \frac{3}{2(n_1 - n_2)}, \frac{5}{2(n_1 - n_2)}$

Time period $T = \frac{1}{(n_1 - n_2)}$

Frequency $f = (n_1 - n_2)$

$\frac{1}{2(n_1 - n_2)}$ $\frac{3}{2(n_1 - n_2)}$ $\frac{5}{2(n_1 - n_2)}$

$\frac{1}{2(n_1 - n_2)}$ $\frac{3}{2(n_1 - n_2)}$ $\frac{5}{2(n_1 - n_2)}$

$\cancel{\frac{1}{(n_1 - n_2)}}$ $\frac{1}{(n_1 - n_2)}$ $\frac{2}{(n_1 - n_2)}$ $\frac{3}{(n_1 - n_3)}$

b) wave Equation in differential form:

consider a equation of plane progressive wave

$$y = a \sin \frac{2\pi}{\lambda}(vt - x) \quad -(1)$$

Differentiate eq n (1) w.r. to time

$$\frac{dy}{dt} = a\left[\cos \frac{2\pi}{\lambda}(vt - x)\right]\left[\frac{2\pi v}{\lambda}\right]$$

$$\frac{dy}{dt} = \frac{2\pi a v}{\lambda} \cos \frac{2\pi}{\lambda}(vt - x) \quad -(2)$$

Again diff eq (2) w.r. to time

$$\frac{d^2y}{dt^2} = \frac{2\pi a v}{\lambda}\left[-\sin \frac{2\pi}{\lambda}(vt - x)\right]\left[\frac{2\pi v}{\lambda}\right]$$

$$\frac{d^2y}{dt^2} = \frac{-4\pi^2 a v^2}{\lambda^2} \sin \frac{2\pi}{\lambda}(vt - x] \quad -(3)$$

Diff eq n (1) w.r. to. x

$$\frac{dy}{dx} = a\left[\cos \frac{2\pi}{\lambda}(vt - x)\right]\left[\frac{2\pi(-1)}{\lambda}\right]$$

$$\frac{dy}{dx} = \frac{-2\pi a}{\lambda} \cos \frac{2\pi}{\lambda}(vt - x) \quad -(4)$$

Again diff eq n (4) w.r. to. x

$$\frac{d^2y}{dx^2} = -\frac{2\pi a}{\lambda}\left[-\sin \frac{2\pi}{\lambda}(vt - x)\right]\left[\frac{2\pi}{\lambda}(-1)\right]$$

$$\frac{d^2y}{dx^2} = -\frac{2\pi a}{\lambda}\left[-\sin \frac{2\pi}{\lambda}(vt - x)\right]\left(\frac{2\pi}{\lambda}(-1)\right)$$

$$\frac{d^2y}{dx^2} = \frac{-4\pi^2 a}{\lambda} \sin \frac{2\pi}{\lambda}(vt - x) \quad -(5)$$

compare equation (2) & (4)

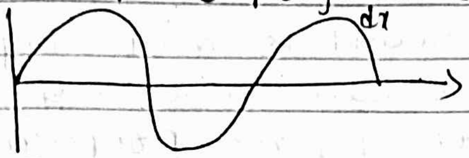
$$\frac{dy}{dt} = -v\frac{dy}{dx}$$

compare equation (3) & (5)

$$\boxed{\frac{d^2y}{dt^2} = -v^2 \frac{d^2y}{dx^2}}$$

2 a) Expression for intensity of progressive wave:

conside an plane progressive wave



Now the potential energy is given by

$du_p = \frac{1}{2} m\omega^2 y^2$

And the kinetic energy is given by

$du_K = \frac{1}{2} mv^2$

plane progressive wave equation can also be written as

$y = a\sin(\omega t - kx)$

velocity $v = \frac{dy}{dt} = a\omega\cos(\omega t - kx)$

$du_p = \frac{1}{2} m\omega^2 a^2 \sin^2(\omega t - kx)$

$du_K = \frac{1}{2} m a^2 \omega^2 \cos^2(\omega t - kx)$

Total Energy = KE + PE

$du = du_p + du_K$

$du = \frac{1}{2} m\omega^2 a^2 [\sin^2(\omega t - kx) + \cos^2(\omega t - kx)]$

$du = \frac{1}{2} m\omega^2 a^2$

Cosider linear mass density $\rho = \frac{m}{dx}$

$m = \rho . dx$

So, $du = \frac{1}{2} \rho dx \omega^2 a^2$

This is the energy transport equation

Intensity = Rate of flow of energy

$I = \frac{du}{dt}$

$I = \frac{1}{2} \rho \frac{dx}{dt} a^2 \omega^2$

$I = \frac{1}{2} \rho c a^2 \omega^2$

Put $\omega = 2\pi\nu$

$I = \frac{1}{2} \rho c a^2 (2\pi\nu)^2$

$I = 2\pi^2 \nu^2 \rho c a^2$

This is the intensity of plane progressive wave.

b. Laplace's correction for velocity of Sound

Laplaces correction is given by

i) velocity of Sound is quite high

ii) Gas (air) is bad conductor of heat

iii) According to Laplace propagation of sound in air is adiabatic process.

For an adiabatic process

$$PV^{\gamma} = \text{constant} \quad -(1)$$

where $\gamma = \frac{CP}{CV}$

CP = specific heat capacity at constant P

CV = specific heat capacity at constant volume

Diffe eq (1)

$$P\gamma V^{\gamma-1} dV + V^{\gamma} dP = 0$$

$$P\gamma V^{\gamma-1} dV = -V^{\gamma} dP$$

$$P = \frac{-V^{\gamma} dP}{P\gamma V^{\gamma-1} dV} = \frac{-V^{\gamma-(\gamma-1)} dP}{\gamma dV}$$

$$P = \frac{-V dP}{\gamma dV}$$

$$P = \frac{-dP}{\gamma (dV/V)}$$

$$P = \frac{B_{adiabatic}}{\gamma} \quad -(2)$$

~~$B_{adiabatic} = P\gamma$~~

~~we k.t~~

~~$$v = \sqrt{\frac{B_{adiabatic}}{\rho}}$$~~

$$v = \frac{\sqrt{P\gamma}}{\rho}$$

$$v = \frac{1.41 \times 1.013 \times 10^{5}}{1.293}$$

$$v = 330 \text{ m/s}$$