QUESTION No.1

(a) What is diode? Differentiate b/w Half wave rectifier and Full wave rectifier.

ANSWER

DIODE

A diode is an electronic component that:

- has two terminals
- limits current to one direction.

⇒ Diodes have an anode and cathode.

⇒ positive current normally flows from anode to the cathode.

⇒ Diodes are useful for protecting circuitry from harmful voltage or current.

⇒ Diodes are a basic building block of the charge collecting element in many detectors.

Applications

→ Rectifier circuits;

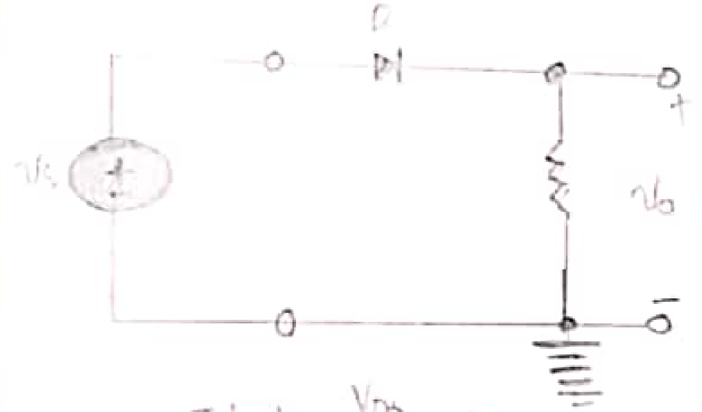
- half wave rectifier
- full wave rectifier

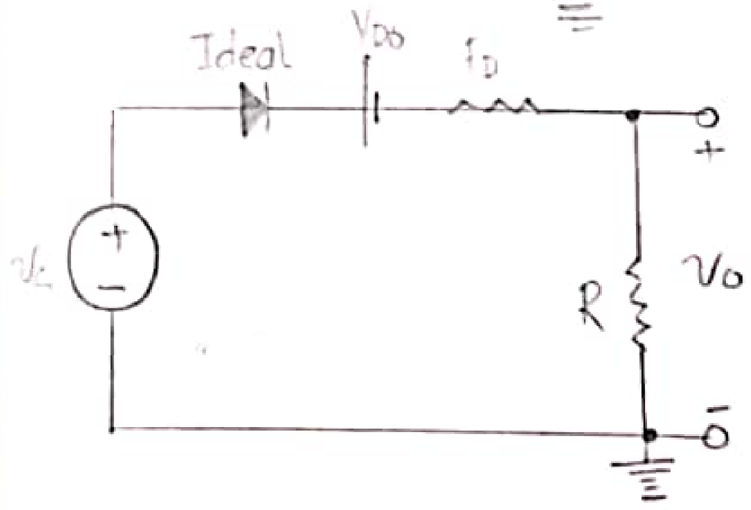
→ Transformer with a center tapped secondary winding:

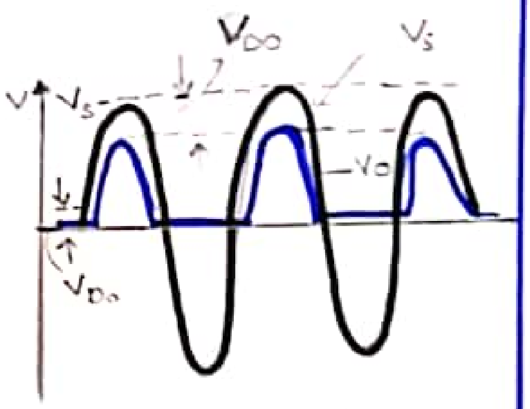
→ Bridge rectifier

Half-wave rectifier

- ⇒ Equivalent circuit of the half wave rectifier with the diode replaced with its battery plus resistance model.
- ⇒ Transfer characteristic of the rectifier circuit.
- ⇒ Input and output wave forms. assuming that $r_D << R$.







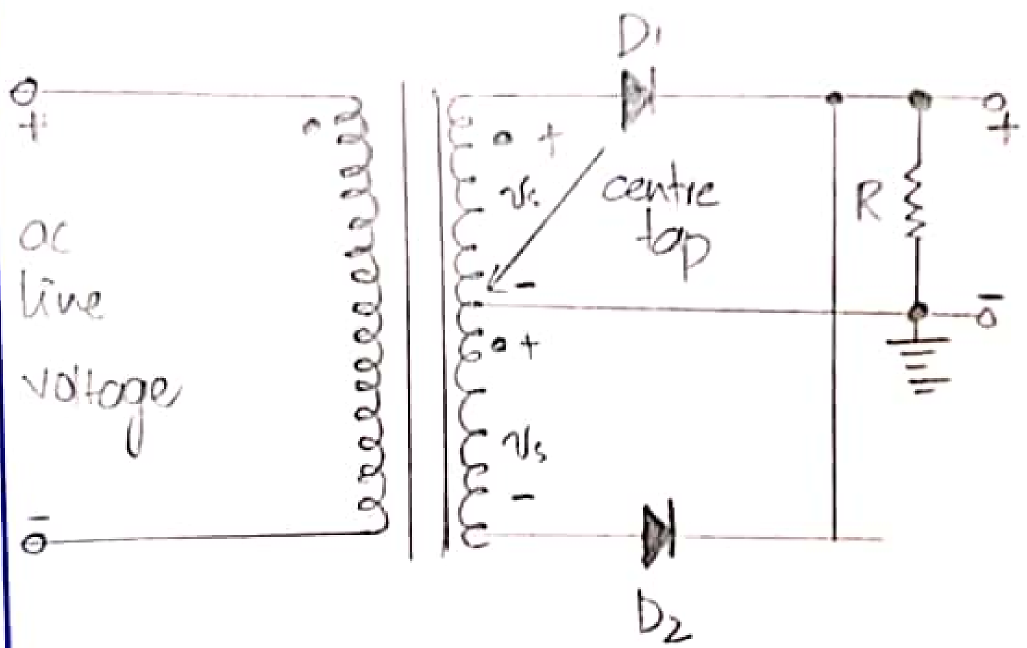
(d)

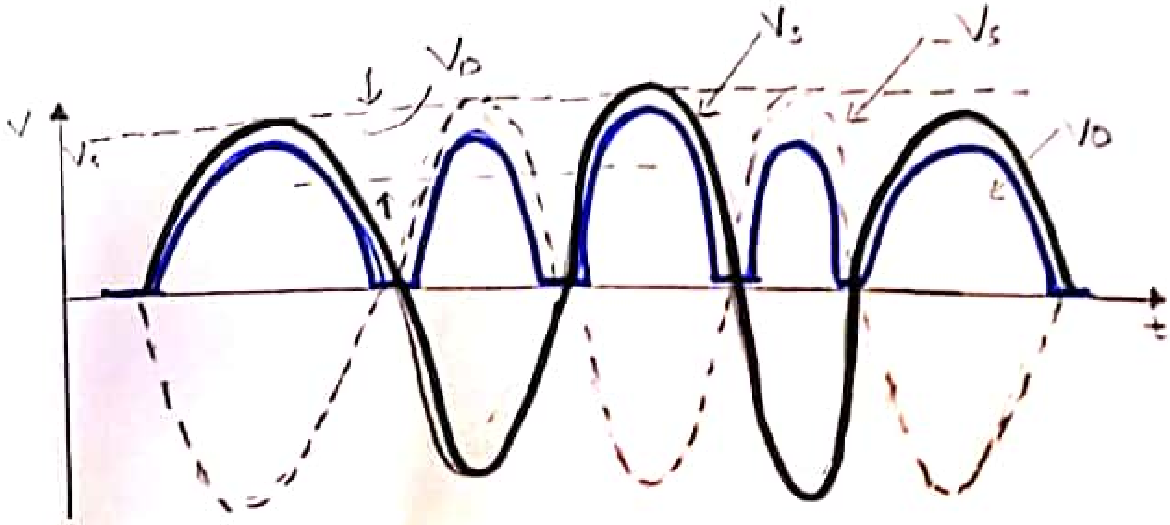
Full-wave Rectifier

(a) circuit

(b) transfer characteristic assuming a constant voltage drop model for the diodes.

(c) input and output waveforms.





(c)

input and output waveforms

(b) Solution

$T = 785°C$

$mass, m = 97\ g$

$T = 15.0\ °C$

$mass = 323\ g$

- Lose heat = Gain heat

$-[(C_{Au})(mass)(\Delta T)] = (C_{H_2O})(mass)(\Delta T)$

$-[(0.129\ J/g°C)(97g)(T_f - 785°C)] = (4.184\ J/g°C)(323g)(T_f - 15°C)$

$-[(12.5)(T_f - 785°C)] = (1.35 \times 10^3)(T_f - 15°C)]$

$-12.5\,T_f + 9.82 \times 10^3 = 1.35 \times 10^3\,T_f - 2.02 \times 10^4$

$3 \times 10^4 = 1.36 \times 10^3\,T_f$

$\boxed{T_f = 22.1°C}$

Question No. 2

a. Explain the isobaric process, Isometric process isothermal process and adiabatic process on the basis of first law of thermodynamics.

Answer

First Law of thermodynamics

- The net heat put into a system is equal to the change in internal energy of the system plus the work done by the system.

$$\Delta Q = \Delta U + \Delta W \quad [\Delta = \text{final} - \text{Initial}]$$

Thermodynamic Processes

- Isobaric Process
- Isothermal Process
- Adiabatic Process
- Isometric or Isochoric Process

1. Isochoric Or Isometric Process

Constant volume, $\Delta V = 0$, $\Delta W = 0$

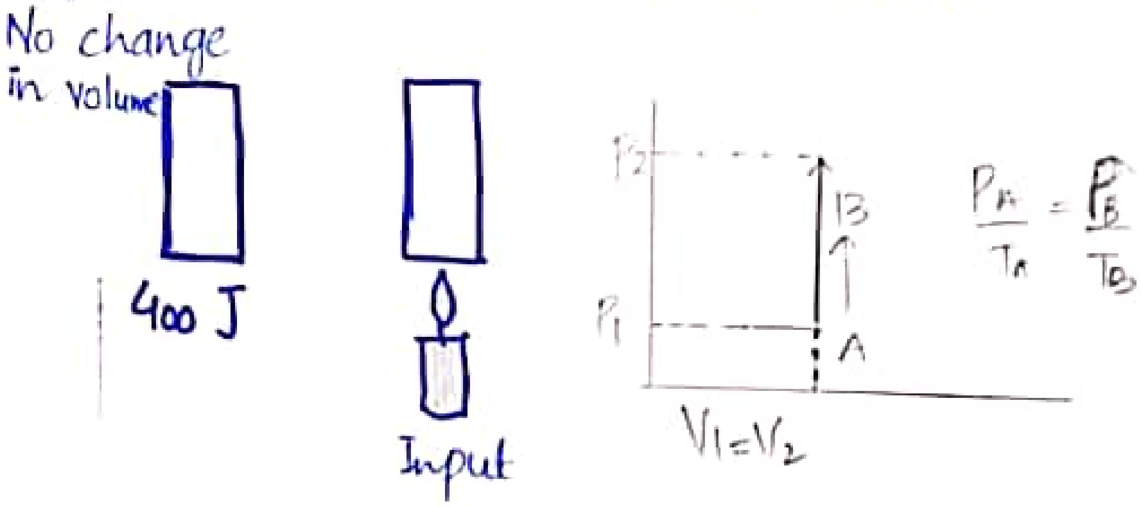
$\Delta Q = \Delta U + \Delta W$ so that $\Delta Q = \Delta U$

Heat in = increase in internal energy

Heat out = decrease in internal energy

Example

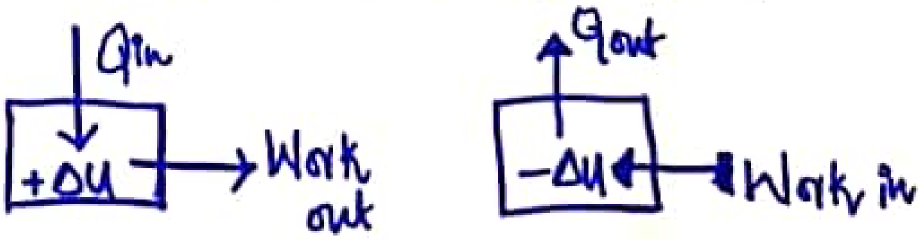
400 J heat input increase internal energy by 400 J and zero work is done.



2. Isobaric Process

Constant pressure, $\Delta P = 0$

$\Delta Q = \Delta U + \Delta W$ But $\Delta W = P\Delta V$

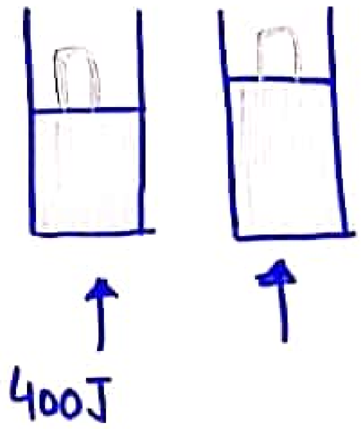


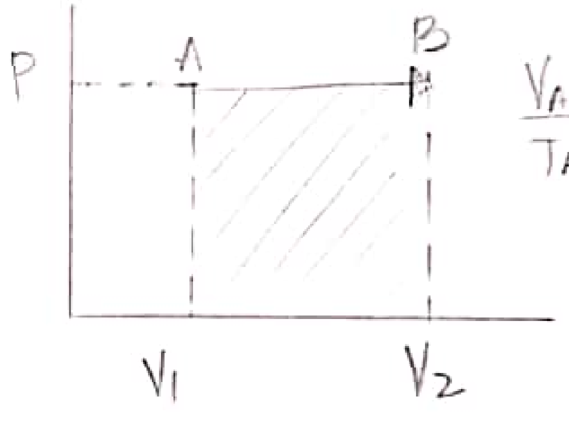
Heat in: W out + increase in internal energy

Heat out: W in + decrease in internal energy.

Example:

400J heat does 120J of work, increasing the internal energy by 280J.





$$\frac{V_A}{T_A} = \frac{V_B}{T_B}$$

isobaric Work

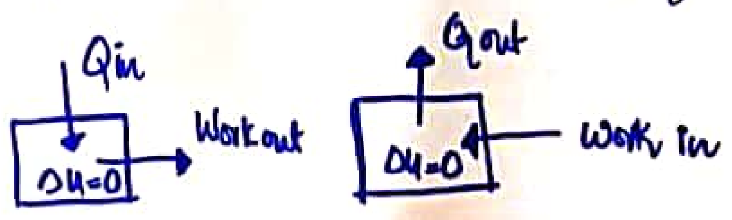
Work = Area under PV curve

Work = $P\Delta V$

3. ISOTHERMAL PROCESS

Constant Temperature, $\Delta T = 0$, $\Delta U = 0$

$\Delta Q = \Delta U + \Delta W$ and $\Delta Q = \Delta W$



heat in: Work output

heat out: Net Work input

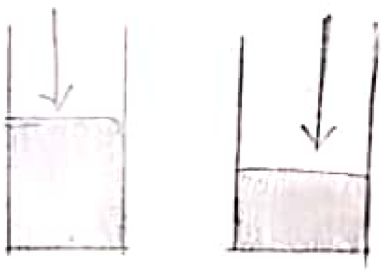
Example:

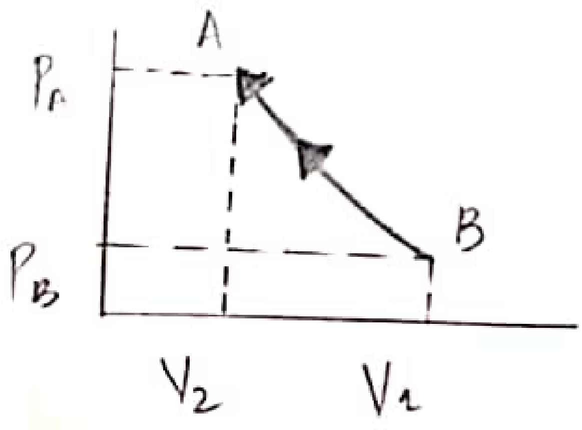
400 J of energy is absorbed by gas as 400 J of work is done on gas.

$$\Delta T = \Delta U = 0$$

isothermal Work

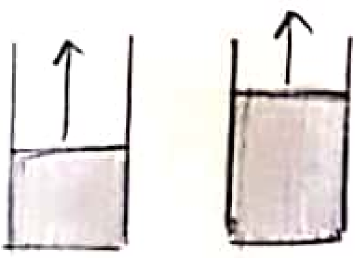
$$W = nRT \ln \frac{V_B}{V_A}$$

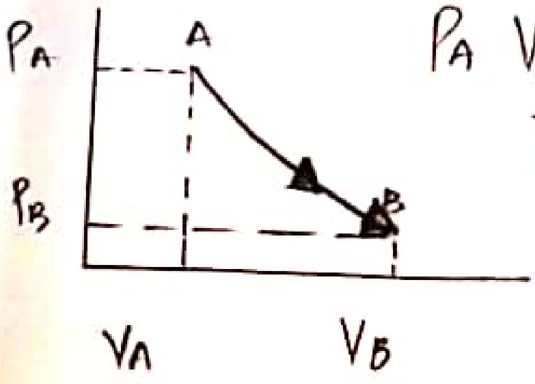




$$\Delta U = \Delta T = 0$$

$$P_A V_A = P_B V_B$$





$$P_A V_A = P_B V_B$$

$$T_A = T_B$$

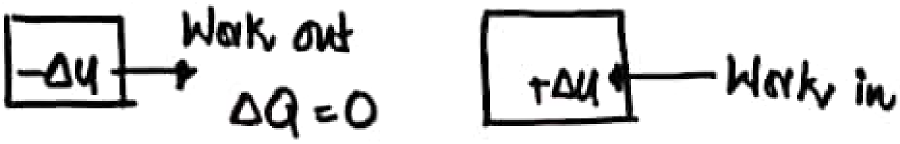
$$\Delta U = \Delta T = 0$$

4. Adiabatic Process

No heat exchange, $\Delta Q = 0$

$\Delta Q = \Delta U - \Delta W$; $-\Delta U$ or $\Delta U = -\Delta W$

$\Delta W = -\Delta U$ $\qquad$ $\Delta U = -\Delta W$



Work done at expense of internal energy

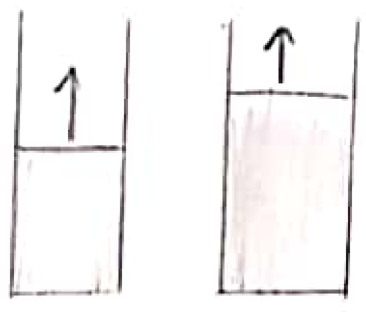
input work increases internal energy

Example:

400 J of work is done decreasing the internal energy by 400 J. Net heat exchange is zero.

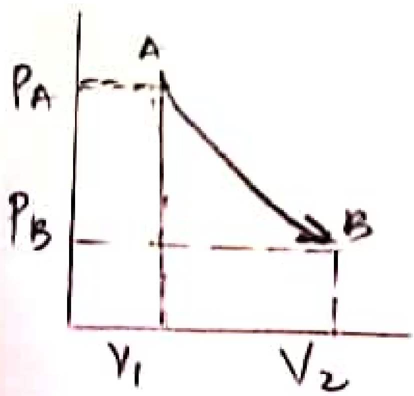
$\Delta Q = 0$

$P_A V_A^{\gamma} = P_B V_B^{\gamma}$



Insulated walls

$\Delta Q = 0$



Work = $-\Delta U$.

(b) Solution:

$$e = 1 - \frac{T_C}{T_H}$$

$$e = 1 - \frac{300k}{500k}$$

$$\boxed{e = 40\%}$$

Actual $e = 0.5 e_i = 20\%$

$$e = W/Q_H$$

$$W = e Q_H = 0.20(600J)$$

$$\boxed{Work = 120J}$$

QUESTION No.3

(a) Differentiate b/w internal combustion and external combustion engine.

ANSWER

I.C. Engine	E.C. Engine
• Combustion of fuel takes place inside the cylinder	• Combustion of fuel takes place outside the cylinder
• Working fluid may be petrol, diesel and various types of gases.	• Working fluid is steam
• Require less space	• Require large space
• Capital cost is relatively low	• Capital cost is relatively high
• Starting of this engine is easy and quick	• Starting of this engine requires time
• Thermal efficiency is high	• Thermal efficiency is low.

• Power developed per unit weight of these engines is high.f.	• Power developed per unit weight of these engines is low.
• Fuel cost is high	• Fuel cost is low

(b) **Solution:**

Find P_B

$$\Delta Q = 0$$

$$P_B = P_A \left[\frac{12 V_B}{V_B}\right]^{1.4}$$

$$P_B = (1\,atm)(12)^{1.4}$$

$$P_B = 32.4\,atm$$

or

$$P_B = 3284\,kPa$$

$$\therefore \frac{P_A V_A}{T_A} = \frac{P_B V_B}{T_B}$$

Find T_B

$$\frac{P_A V_A}{T_A} = \frac{P_B V_B}{T_B}$$

$$\Delta Q = 0$$

$$\frac{(1\,atm)(12\,V_B)}{(300\,k)} = \frac{(32.4\,atm)(1\,V_B)}{T_B}$$

$$\boxed{T_B = 810\,k}$$

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QUESTION No-4

(a) Differentiate b/w conduction and convection

ANSWER

Conduction	Convection
• The heat transfer takes place b/w objects by direct contact.	• The heat tranfer takes place within the fluid.
• Heat transfer is due to difference in temperature.	• Heat tranfer occurs due to difference in density.
• Occurs in solids, through molecular collisions	• Occurs in fluids by actual flow of matter.
• Uses heated solid substance.	• Uses intermediate Substance
• slow process	• slow process.
• doesnot obey law of reflection and refraction.	• doesnot obey laws of reflection and refraction

Examples

Conduction:

⇒ Touching a hot stove and being burned
⇒ Ice coling down your hand
⇒ Biding H_2O thursting a red hot piece of iron on it.

Convection:

⇒ Hot air rising, cooling and falling
⇒ Radiator.

(b) Solution:

$$Q_{water} = -q_{Pb}$$

$$m_{water} C_{water} \Delta T_{water} = -(m_{Pb} C_{Pb} \Delta T_{Pb})$$

$$125(4.18)(T_f - 23) = -75(0.13)(T_f - 435)$$

$$522.5\,T_f - 12017.5 = -9.75\,T_f + 4241.25$$

$$9.75\,T_f + 12017.5 = +9.75\,T_f + 12017.5$$

$$532.25\,T_f = 16258.75$$

$$\boxed{T_f = 30.5^\circ C}$$

QUESTION No. 5

Solution:

The inner and outer surfaces of flat concrete roof of an electrically heated home are maintained at specified temperature during night. The heat loss through the roof and its cost that night are to be determined

Assumption 1

Steady operating ~~sur~~ conditions exists during the entire night. The heat loss through the roof and the surface temperature of the roof remain constant at ~~cons~~ the specified valve.

Assumption 2

a Constant properties can be used ~~d~~ for the roof.

Properties

The thermal conductivity of the roof is given by $k = 0.8\ W/m \cdot C$.

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Analysis:

(a) Nothing that heat transfer through the roof is by conduction and the area of the roof is

$$A = 6m \times 8m = 48 m,$$ the steady rate of heat transfer through the roof is

$$Q = KA \frac{T_1 - T_2}{L} = (0.8 \, W/m \, C)(48 m^2)\frac{(25-0)^\circ C}{0.25 m}$$

$$= 3\% 84k = 3.84 kW$$

(b) The amount of heat lost through the roof during a 10 hours period and its lost is

$$Q = Q \Delta t = (384 \, kw)(10 \, h) = 384 \, kwh$$

Cost = (Amount of energy)(unit Cost of energy)

$$= (38.4/kWh)(0.2/kWh) = \$7.68$$

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