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Section A

Paper Basic Electro Mechanical

Q1 a What is Diode? Differentiate between Half-wave rectification and Full wave rectification.

Ans **Diode:** A diode is a Specialized electronic component with two electrodes called anode and the Cathode. Most diodes are made with Semiconductor materials materials such as silicon, germanium or selenium. Some diodes are comprised of metal electrodes in a Chamber evacuated or filled with a Pure elemental gas at low Pressure. Diodes can be used as rectifies, signal limiters voltage regulators, Switches, signal modulators, signal mixers, signal demodulators and oscillators.

Differentiate between Half wave rectification and Full wave rectification

S.No	Half wave Rectifier	Full wave Rectifier
1	In this, one diode or one semiconductor diode is used.	In this, two diodes or one double diode or two junction diode are used
2	ordinary transformer is used.	Centre tap transformer is used.
3	It converts half cycle of applied A.C signal into D.C signal.	It converts the whole cycle of applied A.C. signal into D.C. signal.
4	The value of $I_{ms} = \frac{I_0}{2}$	$I_{ms} = \frac{I_0}{\sqrt{2}}$
5	$I_{dc} = \frac{I_0}{\pi}$	$I_{dc} = \frac{2I_0}{\pi}$
6	Efficiency (a) $\eta = \frac{40.6}{(1+\frac{r_p}{R_L})}$ (b) when $r_p = R_L$ then $\eta =$	(a) $\eta = \frac{81.2}{(1+\frac{r_0}{R_L})}$ (b) when $r_p = R_L$ then $\eta = 40.6\%$

Q1b:

Sol

$- \text{Lose}_{heat} = \text{Gain}_{heat}$

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

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

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

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

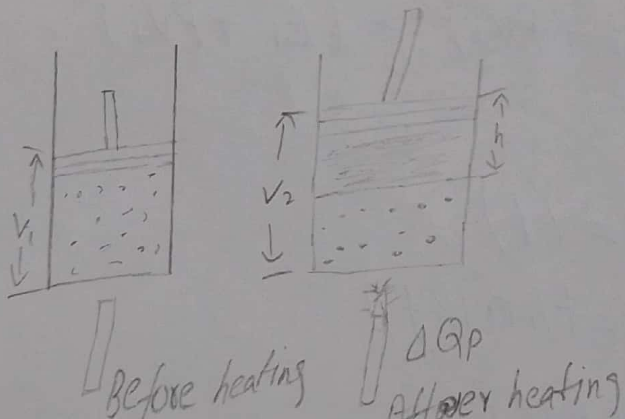
$3 \times 10^4 = 1.36 \times 10^3\ T_f$

$T_f = 22.1°c$

Q2a Explain the Isobaric Process, Isometric Process, Isothermal Process and adiabatic Process on the basis of first law of thermodynamics.

Ans: **Isobaric Process:**

Heat supplied at constant Pressure is also known as "Isobaric Process". An isobaric process is one in which no pressure change take place during the supply of heat of system.



let the internal energy of the system at initial state E_1 the temperature of system T_1 volume of gas is V_1 and Pressure is P.

If q_P amount of heat is supplied to the system, its internal energy will increase from E_1 and E_2 and the temperature of system also rises from T_1 to T_2,

At the same time gas exerts some Pressure on the piston, since the piston is free to move it displace by "h" the volume of gas increase from V_1 to V_2. Due to increase in volume, pressure again decrease to its original value i.e.

According to the First law of thermodynamics:

$$Q_P = \Delta E + work$$

$$Q_P = \Delta E + P\Delta V$$

$$Q_P = \Delta E + P\Delta V \quad \text{but } (\Delta E = E_2 - E_1)$$

$$Q_P = E_2 - E_1 + P(V_2 - V_1)$$

$$Q_P = E_2 - E_1 + PV_2 - PV_1$$

$$Q_P = E_2 + PV_2 - E_1 - PV_1$$

$$Q_P = (E_2 + PV_2) - (E_1 + PV_1)$$

but

$(E + PV = H)$

$(H = \text{enthalpy})$

therefore,

$$q_P = \Delta H$$

OR

$$q_P = \Delta E + P\Delta V = \Delta H.$$

Isothermal Process :

- An isothermal process is a change of a thermodynamic system in which the temperature remain constant.

i) For an ideal gas, the product of pressure and volume (PV) is a constant if the gas is kept at isothermal condition.

ii) For an ideal gas, the work involved when a gas changes from state A to B through an isothermal process is given as $W_{A \to B} = nRT \ln \frac{V_B}{V_A}$.

iii) For many system. If the temperature is held constant, the internal energy of the system also is constant. It follows that $Q = W$ in this case.

Ideal Gas in an Isothermal Process.

$$P = \frac{nRT}{V} = \frac{\text{costant}}{V}$$

Calculation :

$$W_{A \to B} = nRT \int_{V_A}^{V_B} \frac{1}{V}\, dV = nRT \ln \frac{V_B}{V_A}.$$

Adiabatic Process:

An adiabatic Process is one in which no heat is gained or lost by the system. The first law of thermodynamics with $Q=0$ Show that all the change in internal energy is in the form of work done. This puts a constraint on the heat engine Process leading to the adiabatic Process. This condition can be used to derive the expression for the work done during an adiabatic Process.

The adiabatic condition

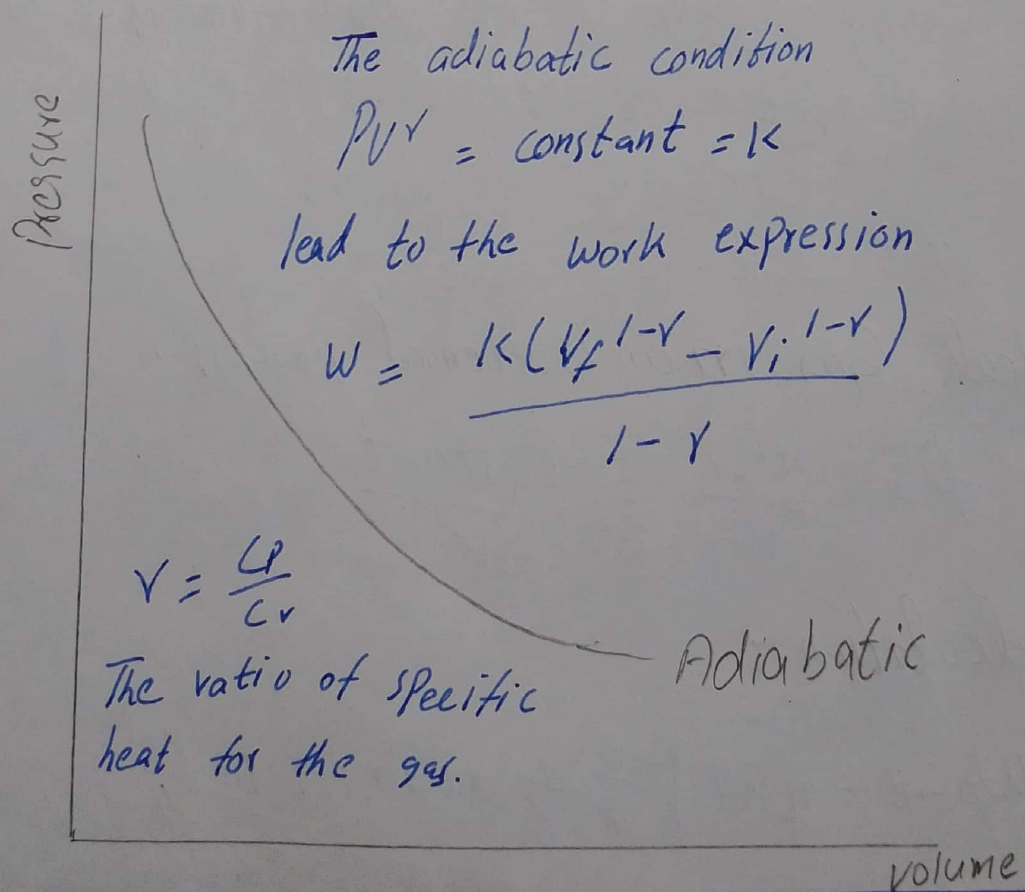
$$PV^{\gamma} = \text{constant} = K$$

lead to the work expression

$$W = \frac{K(V_f^{1-\gamma} - V_i^{1-\gamma})}{1-\gamma}$$

$$\gamma = \frac{C_P}{C_V}$$

The ratio of specific heat for the gas.



Q2b

Solution

Formula

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

Putting the Values in formula

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

$e = 40\%$

Actual $e = 0.5e_i = 20\%$

$$e = \frac{W}{Q_H}$$

$W = eQ_H = 0.20(600J)$

work $= 120J$

Q3a Differeniate between internal combustion engine and external combustion engine.

Ans **Internal combustion engine:** In an internal combustion engine, the working fluid consists of a combustion fluid placed inside a cylinder these engines, the fluid undergoes combustion inside the cylinder and expands.

External combustion Engine: In an exteral combustion engine the combustion take place outside the cylinder. Heat than need to be transferred to the cylinder where work is done. Steam engines are an example of external combustion engines.

Difference between Internal combustion engine and External combustion engine

1 External combustion engine run Smoothly and Silently where of internal combustion engines are very noisy. Noise product from continous explosions inside the cylinder of Internal combustion engine.

2 working, Pressure and temperature in external combustion is low whereas in Internal combustion engine working Pressure and temperature is high.

3 External combustion engine have 15-20% efficiency whereas Internal combustion engine have 35-60%

4 An external combustion engine requires a boiler and other component to transfer energy. Thus it is a heavy engine where as in an Internal combustion engine Parts are light and compact.

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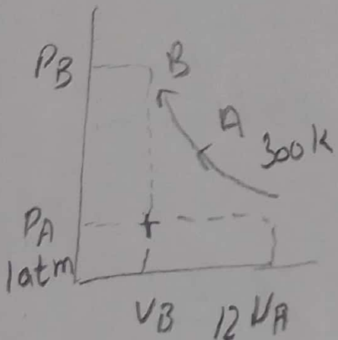
Q3b

Solution



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

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

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

Solve for P_B:

$$P_B = P_A \left(\frac{V_A}{V_B}\right)^{\gamma}$$

$$P_B = P_A \left(\frac{12 V_B}{V_B}\right)^{1.4}$$

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

$$P_B = 32.4\ atm$$

or

3284 kPa

Qu4a Differentiate b/w conduction and convection.

Ans.

Conduction	Convection
In conduction heat transfer take place b/w objects by direct contact.	It convection the heat transfer takes within the fluid.
The heat transfer takes place due to the difference in temperature	The heat tranfer occure due to the differentce in density
The heat transfer in Conduction is Slow	The heat tranfer in convection is faster.
It does not follow the law of reflection and refraction.	It does not follow the law of reflection and refraction.

Q4b

Sol

Given Data

$m_{Pb} = 75g$

$C_{Pb} = 0.13\ J/g\ °C$

Initially $T = 435°C$

Now

Q $m_{water} = 125g$

$c_{water} = 4.18\ J/g\ °C$

Initially = $T = 23°C$

Required Data:

$T_f = ?$

Solution

we know that

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

Now

$m_{water}\ c_{water}\ \Delta T_{water} = -m_{Pb} \cdot C_{Pb}\ \Delta T_{Pb}$

Putting the values

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

$$522.5\,(T_f - 23) = -9.75\,(T_f - 435)$$

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

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

$$532.25\,T_f = 16258.75$$

$$T_f = \frac{16258.75}{532.25}$$

$$T_f = 30.55\,^\circ C$$

Q5

Given Data

$l = 6m$

$w = 8m$

$L = 0.25m$

$K = 0.8\ W/m°C$

$T_1 = 25°C$

$T_2 = 0°C$

$t = 10$ hours, cost $= \$0.2/kWh$

Now

(a) $\bar{Q} = ?$

(b) cost $= ?$

Solution (Part a)

We know that

$A = 6m \times 8m$

$A = 48m^2$

Now we know that.

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$\bar{Q} = KA \frac{(T_1 - T_2)}{L}$

Putting the values

$\bar{Q} = (0.8)(48) \frac{(25-0)}{0.25}$

$\bar{Q} = 38.4 \frac{25}{0.25}$

$\bar{Q} = \frac{960}{0.25}$

$\bar{Q} = 3840 \, W$

$Q = 3.84 \, KW$

Solution (Part b)

We know that

$Q = \bar{Q} \Delta t$

$Q = (3.84K)(10)$

$Q = 38.4 \, KWh$

Now :. cost

cost = (Amount of energy) (unit cost of energy)

~~cost = $ 7.6~~

cost = (38.4k) (0.2)

cost = $ 7.68/day

& now cost per month

cost = (cost / day) (30day/month)

cost = ($ 7.68) (30)

cost = $ 230.4/ month

Now cost per year

cost = (cost/month) (12 month/year)

cost = ($ 230.4) (12)

cost = $ 2764.8/year.