end of the compression stroke if the la[w]
for the compression is $pV^{1.35}$ = constant.

(4) Three cubic feet of a gas are (4)
expanded in a cylinder which causes
the pressure to fall from 100 lbf/in².
To 35 lbf/in². If the expansion follows the
law $pV^{1.1}$ = constant, Find the final
volume of the gas.

(5) The specific heat of a gas at constant
pressure and constant volume are
0.235 and 0.174 respectively; Find the
value of $\gamma$ for this gas. If 4 lbf of this
gas are heated from 60° to 312°F,
Find the heat absorb if the heating
takes place at (1) constant pressure
(2) constant volume.

(6) The value of $\gamma$ for a certain gas is
1.38 and its specific heat at constant
pressure is 0.25. Find the heat given
out when 0.16 lbf of this gas is cooled
at constant volume from 360° to 20°C.

(7) Steam occupying a volume of 1.3 ft³
is expanded in an engine cylinder from
an absolute pressure of 160 lbf/in². To an
absolute pressure of 3 lbf/in². Find the
final volume of the stream and the
work done on the piston if the

pansion follows a law $pV^{1.13}$ = constant.

(8) A volume of $3.5 ft^3$ of steam at a pressure of $85 lbf/in^2$. (abs) is expanded hyperbolicly to a pressure of $14.5 lbf/in^2$ (abs). Find the work done by steam. (5).

(9) A Diesel engine has a cylinder diameter of 12 in. and a stroke of 18 in. The comparison ratio is 13.5. Pure air at a pressure of $14.7 lbf/in^2$ (~~abs~~) is sucked into the cylinder during the suction stock and is compressed into the clearance volume during the compression stroke. Find the work done during the compression stroke. If the compression is assumed to be reverseble adiabatic.

(10) Ten cubic feet of air ~~at~~ a pressure of $40 lbf/in^2$. is expanded to a volume of $25 ft^2$. Find the work done during the expansion of each of the following methods of expansion. (a) constant pressure (b) isothermal (c) Free 3
(d) reversible adiabatic (e) Follows the law $pV^{1.2}$ = constant (f) hyperbolic.

P-1.4)

Data:-

$V_1 = 3\ ft^3$

$P_1 = 100\ lb_f/in^2$

$P_2 = 35\ lb_f/in^2$

$V_2 = ?$

$PV^{1.1} = const.$

Solution:-

As the expansion follows the law:

$$P_1 V_1^{1.1} = P_2 V_2^{1.1}$$

$$V_2 = \left(\frac{P_1}{P_2}\right)^{1/1.1} V_1$$

$$= \left(\frac{100}{35}\right)^{1/1.1} 3$$

$$\boxed{V_2 = 7.79\ ft^3}$$

P-1.5)

Data:-

$C_p = 0.235$

$C_v = 0.174$

$\gamma = ?$

$w = 4\ lb_f$

$T_1 = 60°F$

$T_2 = 312°F$

$Q_p = ?$

$Q_v = ?$

Solution:-

As $\gamma = \frac{C_p}{C_v}$

$$\gamma = \frac{0.235}{0.174}$$

$$\boxed{\gamma = 1.35}$$

As

$Q_p = W\ C_p\ (T_2 - T_1)$

$= 4 * 0.235\ (312 - 60)$

$$\boxed{Q_p = 236.88\ \text{B.T.U}}$$

Similarly;

$Q_v = W\ C_v\ (T_2 - T_1)$

$= 4 * 0.174\ (312 - 60)$

$$\boxed{Q_v = 175.39\ \text{B.T.U}}$$

P-1.6)

Data:-

$\gamma = 1.38$

$C_p = 0.25$

$W = 0.16\ lb_f$

$T_2 = 20°C$

$T_1 = 360°C$

$Q_v = ?$

Solution:-

As $\frac{C_p}{C_v} = \gamma$

$$C_v = \frac{C_p}{\gamma} = \frac{0.25}{1.38}$$

$C_v = 0.181$

* IRFAN MARWAT

SECTION "B"

As

$Q_v = w C_v (T_2 - T_1)$

$= 0.16 \times 0.181 (20 - 360)$

$Q_v = -9.855$ Chu

where:

-ve sign shows that gas is cooled or heat is rejected.

=>

$Q_v = 9.855$ Chu

P-1.7)

Data:-

$V_1 = 1.3\ ft^3$

$P_1 = 160\ lbf/in^2$

$P_2 = 3\ lbf/in^2$

$V_2 = ?$

Work done = ?

$PV^{1.13} = Const.$

Solution:-

As the expansion follows the law:

$P_1 V_1^{1.13} = P_2 V_2^{1.13}$

$V_2 = V_1 \left(\frac{P_1}{P_2}\right)^{1.13}$

$= 1.3 \left(\frac{160}{3}\right)^{1.13}$

$V_2 = 43.87\ ft^3$

Now work done in this expansion will be:

$$\text{Work done} = \frac{P_1 V_1 - P_2 V_2}{n-1}$$

$$= \frac{(160 * 1.3 - 3 * 43.8)\,144}{1.13 - 1}$$

**Work done = 84585.33 ft-lbf**

P-1.8)

Data:-

$V_1 = 3.5\ ft^3$

$P_1 = 85\ lbf/in^2$

$P_2 = 14.5\ lb/in^2$

Work done = ?

Solution:-

As the gas is expanded hyperbolically; So

$$P_1 V_1 = P_2 V_2$$

$$V_2 = \frac{P_1 V_1}{P_2}$$

$$= \frac{85}{14.5} * 3.5$$

$$V_2 = 20.51\ ft^3$$

Now

$$\text{Work done} = P_1 V_1 \ln\left(\frac{V_2}{V_1}\right)$$

$$= 85 * 144 * 3.5 \ln\left(\frac{20.51}{3.5}\right)$$

**Work done = 75762.65 ft-lbf**

P-1-9)

Data:-

$d = 12$ inch $= 1$ ft

Stroke $= 18$ inch $= 1.5$ ft

$P_1 = 14.7$ $lb_f/in^2$

$\frac{V_1}{V_2} = 13.5$

Work done = ?

Solution:-

As

Clearance Volume $= V_1 - V_2 = \pi \frac{d^2}{4} * \text{stroke}$

$V_1 - V_2 = \pi \frac{1}{4} 1.5$

$V_1 - V_2 = 1.178$ --- ①

Also

$\frac{V_1}{V_2} = 13.5$

$V_1 = 13.5 V_2$ ---- ②

putting in eq (1)

$13.5 V_2 - V_2 = 1.178$

$V_2 = 0.0942$ $ft^3$

⇒ eq ②

$V_1 = 1.272$ $ft^3$

Now:

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

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

$= \frac{14.7 * 144 * (1.272)^{1.40}}{(0.0942)^{1.40}}$

$P_2 =$ [illegible]

$P_2 = 562.24$ $lbf/in^2$ 39

As

As the process is reversible adiabatic.

$$\text{Work done} = \frac{P_1V_1 - P_2V_2}{\gamma - 1}$$

$$= \frac{14.7 * 1.272 - 569.24 * 0.0942}{1.4 - 1}$$

Work.done = −12335 ft-lbf

As work is done on the system, hence −ve sign comes:
So,

| Work done = 12335 ft-lbf |
|---|

P-1.10)
Data:-
$V_1 = 10\ ft^3$
$P_1 = 40\ lb_f/in^2 = 40 * 144\ lb_f/ft^2$
$V_2 = 2.5\ ft^3$
Work done = ?
(a) Iso baric
(b) Iso thermal
(c) Free expansion
(d) Reversible adiabatic.
(e) Follows the law $PV^{1.2}$ = const.
(f) Hyperbolic

Solution:-

(a). At const. pressure.

$$\text{Work done} = P(V_2 - V_1)$$
$$= 40(25-10)\ 144$$

**Work done = 86400 ft-lbf**

(b) In Iso thermal process:

$$\text{Work done} = P_1V_1 \ln\left(\frac{V_2}{V_1}\right)$$
$$= 40*144*10 \ln\left(\frac{25}{10}\right)$$

**Work done = 52778 ft-lbf**

(c) As in free expansion.

**Work done = 0**

(d) In reversible adiabatic process:

$$P_1V_1^{\gamma} = P_2V_2^{\gamma}$$

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

$$= \left(\frac{10}{25}\right)^{1.4} 40$$

$$P_2 = 11.09\ \text{lbf/in}^2$$

Now

41

Work done $= \dfrac{P_1V_1 - P_2V_2}{\gamma - 1}$

$= \dfrac{(40*10 - 11.09*25)144}{1.4 - 1}$

| Work done = 44187 ft - lbf |
|---|

(e) As the process follows the law:

$P_1V_1^{1.2} = P_2V_2^{1.2}$

$P_2 = \left(\dfrac{V_1}{V_2}\right)^{1.2} P_1$

$= \left(\dfrac{10}{25}\right)^{1.2} * 40$

$P_2 = 13.32$ lbf/in$^2$

Now

Work done $= \dfrac{P_1V_1 - P_2V_2}{n - 1}$

$= \dfrac{(40*10 - 13.32*25)144}{1.2 - 1}$

| Work done = 48240 ft - lbf |
|---|

(f) As hyperbolic & Isothermal processes are the same

so

| Work done = 52778 ft - lbf |
|---|