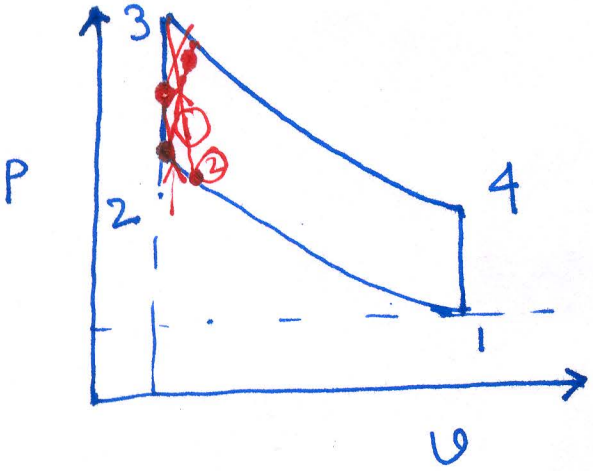
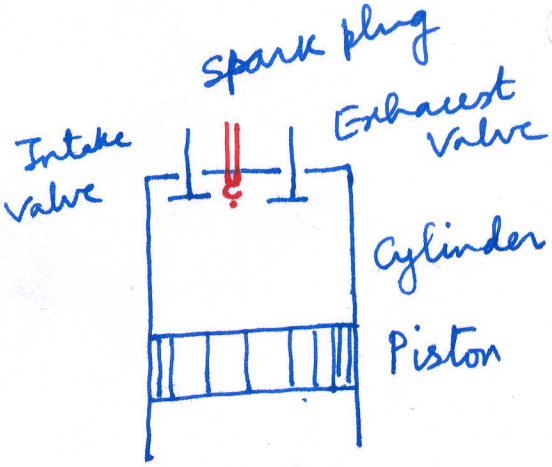
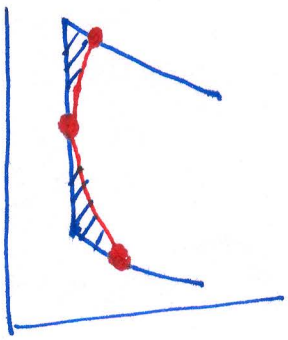


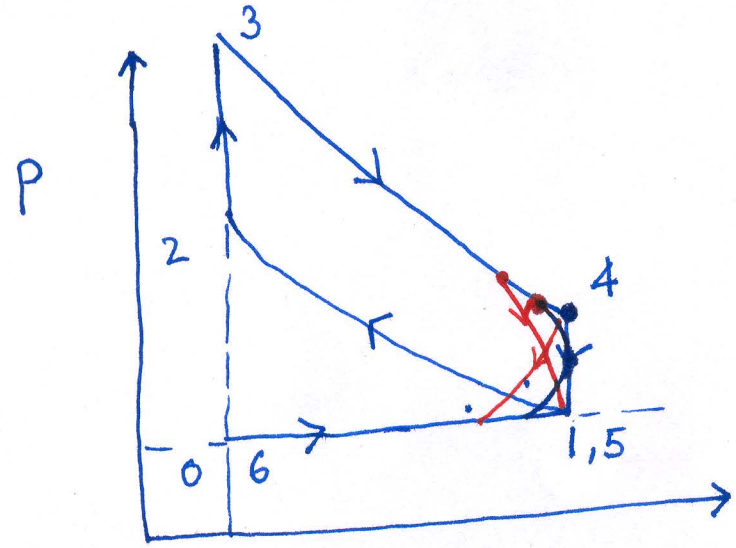


Rate of pressure rise $\frac{dp}{dt}$ or $\frac{dp}{d\theta}$

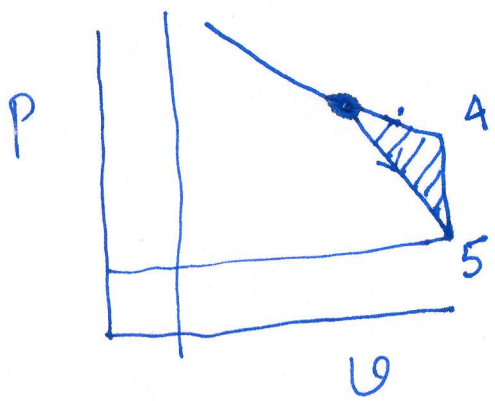
① Spark initiated at TDC

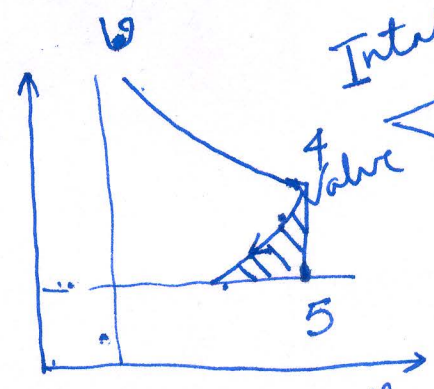
② Spark initiated before TDC

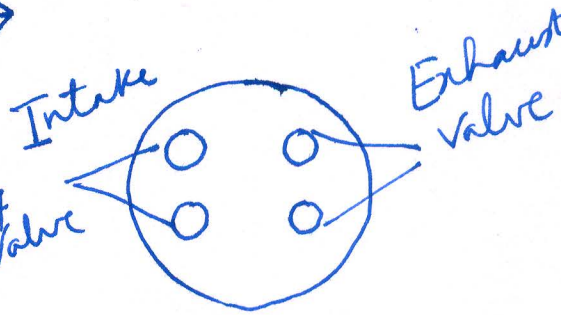


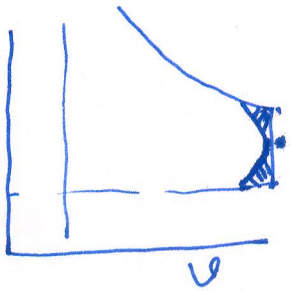


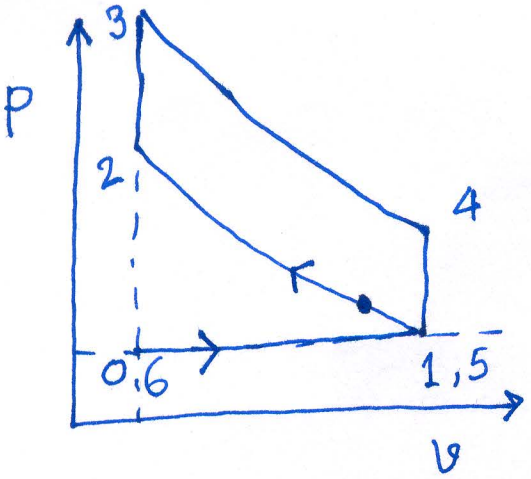
6-1-2-3-4-5-6

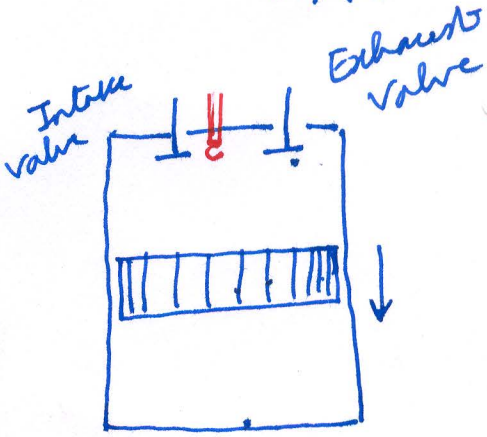






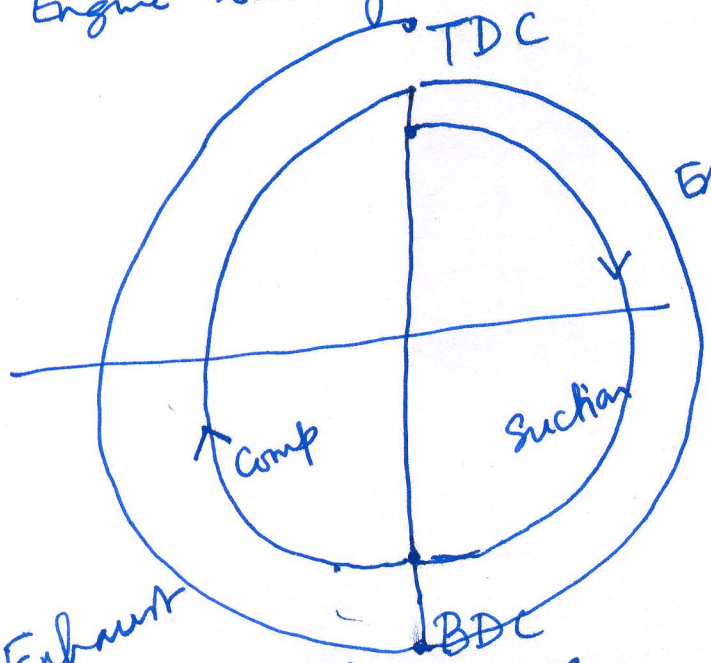


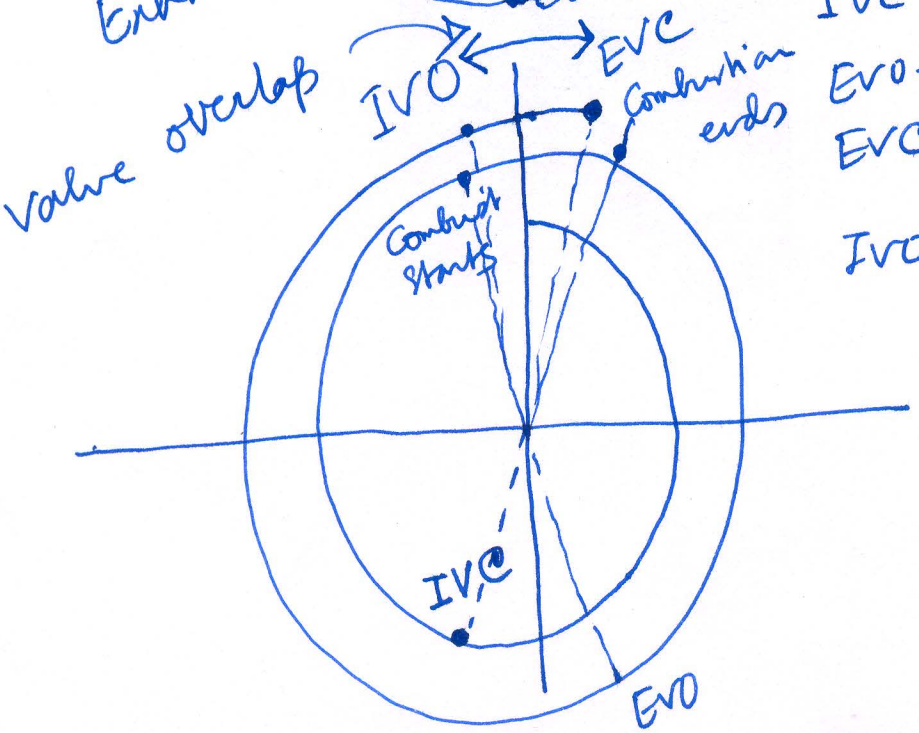




Ram effect

Engine timing





IVC - Intake valve closes

EVO - Exhaust valve opening

EVC - Exhaust valve closes

IVO - Intake valve opens

C_4H_8 is burned in an engine with a fuel-rich air-fuel ratio. Dry analysis of the exhaust gives the volume percents: $CO_2 = 14.95\%$, $C_4H_8 = 0.75\%$, $CO = 0\%$, $H_2 = 0\%$, $O_2 = 0\%$ with the rest being N_2. Higher heating value of this fuel is $Q_{HHV} = 46.9\ MJ/kg$. Write the balanced chemical equation for one mole of this fuel at these conditions:

Calculate: (a) Air-fuel ratio, (b) Equivalence ratio.

$$\frac{17.95}{4} * C_4H_8 + 22.42(O_2 + 3.76N_2) \rightarrow 14.95\,CO_2 + 0.75\,C_4H_8 + 84.3\,N_2 + y'\,H_2O$$

4.49 $\qquad$ 14.96

$$\frac{84.3}{3.76} = 22.42$$

$$14.95 + 0.75 \times 4$$

$$= 17.95$$

$$4.49 \times 8 = 0.75 \times 8 + 2y \qquad y \Rightarrow$$

$$y = 14.96$$

$$C_4H_8 + 5(O_2 + 3.76N_2) \rightarrow 3.33\,CO_2 + 0.167\,C_4H_8 + 18.77\,N_2 + 3.33\,H_2O$$

Air = 28.97 lb/lbmole

$$AF = \frac{5 \times 4.76 \times 28.97}{4 \times 12 + 8 \times 1}$$

$$= 12.3$$

$$C_4H_8 + 6(O_2 + 3.76N_2) \rightarrow 4CO_2 + 4H_2O + 22.56\,N_2$$

$\frac{6}{\phi}$

$$\phi = \frac{(FA)_{act}}{(FA)_{stoic}} = \frac{(AF)_{stoi}}{(AF)_{act}} = \frac{6 \times 3.76 \times \cdots}{5 \times 3.76 \times \cdots}$$

$$= 1.2$$