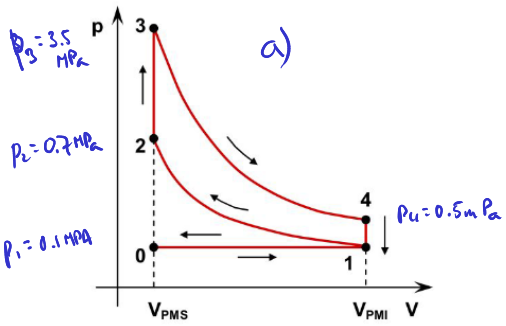
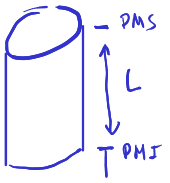
Problema 1



a)

$V_2 = V_{PMI} = 480\,cc \qquad V_1 = V_{PMS} = 120\,cc.$

b) Cilindrada $\quad V_c = V_{PMI} - V_{PMS} = (480 - 120)\,cc = \boxed{360\,cc}$



$V_c = L \cdot S' \Rightarrow L = \frac{V_c}{S'} = \frac{V_c}{\pi \left(\frac{\phi}{2}\right)^2} = \frac{360\,cm^3}{\pi \cdot (3\,cm)^2} = 12{,}73\,cm$

$\phi = 60\,mm = 6\,cm$

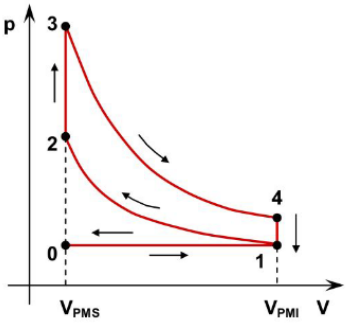
c) Relación volumétrica: $\quad R = \frac{V_{PMI}}{V_{PMS}} = \frac{480\,cc}{120\,cc} = \boxed{4}$

d) Rendimiento si $\gamma = 1.4$ $\quad \eta = 1 - \frac{1}{R^{\gamma-1}} = 1 - \frac{1}{4^{0.4}} = 0{,}425 \quad \boxed{42{,}5\,\%}$

Problema 2

$\eta = 1 - \frac{1}{R^{\gamma-1}} \qquad \eta = \frac{W}{Q_1} \qquad W = W_{34} - W_{12} \qquad W_{01} = W_{10}$ (se compensan)

$Q_1 = Q_{23}$



a) $W_{34} = -\Delta U = -n C_v (T_4 - T_3)$

a) $W_{12} = -\Delta U = -n C_v (T_2 - T_1)$ $\Big\}$ W

b) $Q_1 = Q_{23} = \Delta U_{23} = n C_v (T_3 - T_2)$

$$\eta = \frac{-n C_v (T_4 - T_3) - n C_v (T_2 - T_1)}{n C_v (T_3 - T_2)} = \frac{-T_4 + T_3 - T_2 + T_1}{T_3 - T_2} =$$

$$\eta = \frac{(T_3 - T_2) - (T_4 - T_1)}{T_3 - T_2} = 1 - \frac{T_4 - T_1}{T_3 - T_2}$$

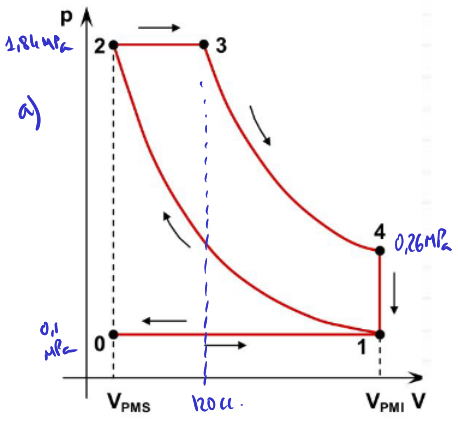
En las adiabáticas: $\quad pV^\gamma = cte \qquad pV\,V^{\gamma-1} = cte \qquad \frac{nRTV^{\gamma-1}}{nR\ es\ cte} = cte \Rightarrow \boxed{TV^{\gamma-1} = cte}$

Luego tenemos $\left.\begin{aligned} T_1 V_1^{\gamma-1} &= T_2 V_2^{\gamma-1} \\ T_3 V_3^{\gamma-1} &= T_4 V_4^{\gamma-1} \end{aligned}\right\}$ pero $\left.\begin{aligned} V_1 = V_4 &= V_{PMI} \\ V_2 = V_3 &= V_{PMS} \end{aligned}\right\} \Rightarrow \boxed{\begin{aligned} T_1 V_{PMS}^{\gamma-1} &= T_2 V_{PMS}^{\gamma-1} \\ T_2 V_{PMI}^{\gamma-1} &= T_3 V_{PMS}^{\gamma-1} \end{aligned}}$ $\Big\}$ $\frac{T_1}{T_4} = \frac{T_2}{T_3}$

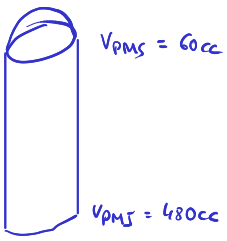
$T_4/T_1 = T_3/T_2$

$$\eta = 1 - \frac{T_1 \left(\frac{T_4}{T_1} - 1\right)}{T_2 \left(\frac{T_3}{T_2} - 1\right)} = 1 - \frac{T_1}{T_2} \frac{\left(\frac{T_3}{T_2} - 1\right)}{\left(\frac{T_3}{T_2} - 1\right)} = 1 - \frac{T_1}{T_2} = 1 - \frac{V_{PMS}^{\gamma-1}}{V_{PMS}^{\gamma-1}} = 1 - \frac{1}{\left(\frac{V_{PMI}}{V_{PMS}}\right)^{\gamma-1}} = 1 - \frac{1}{R^{\gamma-1}}$$

Problema 3. Ciclo Diesel teórico. $\phi = 60$ mm



a)



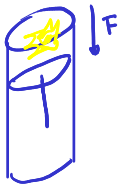
b) Cilindrada:

$V_c = V_{PMI} - V_{PMS} = 420\,cc.$

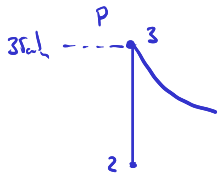
$L = \frac{V_c}{S} = \frac{420\,cc}{\pi\left(\frac{6cm}{2}\right)^3} = 14,85\,cm$

c) $R = \frac{V_{PMI}}{V_{PMS}} = \frac{60\,cc}{480\,cc.} = 8$

Problema 4



$\phi = 75$mm $p = 35$atm



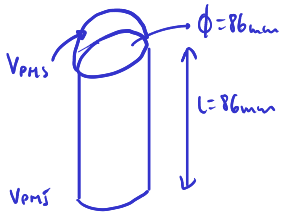
$p = \frac{F}{S} \Rightarrow F = p \cdot S$

$F = p \cdot \pi\left(\frac{\phi}{2}\right)^2 = \frac{p \cdot \pi \cdot \phi^2}{4} = \frac{35\,atm \cdot \pi \cdot 75^2\,mm^2}{4} \cdot \frac{101325\,Pa}{1\,atm} \cdot \frac{1\,m^2}{10^6\,mm^2} =$ N

$F = 1566,4\,N \cdot \frac{1\,kp}{9,8\,N} = 1598,7\,kp$

Problema 5 N°cilindros 4, $\phi = 86$mm, $L = 86$mm $R = 10.4$

a) Cilindrada del pistón y del motor



$V_c = V_{PMI} - V_{PMS} = L\pi\left(\frac{\phi}{2}\right)^2 = \frac{\pi}{4}(8,6cm) \cdot (8,6cm)^2 = 499,55\,cc \simeq 500\,cc$ 1 pistón

Motor $4V_c \simeq 2000\,cc$

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b) Volumen cámara combustión (V_{PMS}) $R = \frac{V_{PMI}}{V_{PMS}}$ $V_{PMI} - V_{PMS} = V_c$

$V_{PMI} = R \cdot V_{PMS} \Rightarrow R V_{PMS} - V_{PMS} = V_c \Rightarrow (R-1) V_{PMS} = V_c \Rightarrow V_{PMS} = \frac{V_c}{R-1} = \frac{499,55\,cc}{10,4-1} = 53,14\,cc$

c) Volumen total cilindro: $V_c = 499{,}55\,cc$ $V_{PMS} = 53{,}14\,cc$

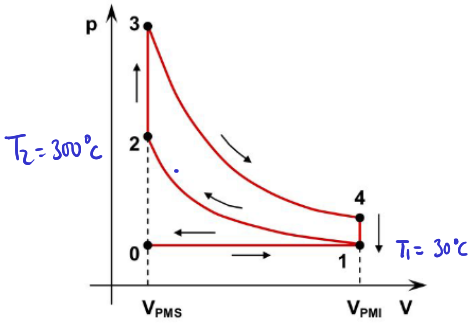
$V_c = V_{PMI} - V_{PMS} = 499{,}55\,cc \Rightarrow$ $V_{PMI} = V_c + V_{PMS} = 552{,}69\,cc$

d) Calcular potencia máxima.

$$P_{max} = M \cdot w = \frac{M \cdot \pi \cdot n}{30} = \frac{164\,Nm \cdot \pi \cdot 6500\,rpm}{30} = 111631{,}3\,W = 111{,}6\,kW$$

(Watios)

Problema 6.



$T_1 V_{PMI}^{\gamma-1} = T_2 V_{PMS}^{\gamma-1}$ es una adiabática. $\gamma = 1.4$

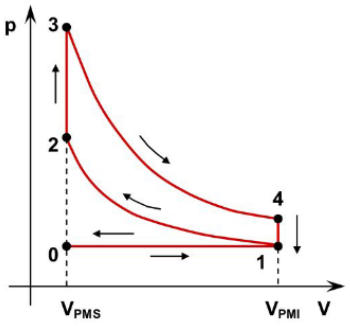
$$\left(\frac{V_{PMI}}{V_{PMS}}\right)^{\gamma-1} = R^{\gamma-1} = \frac{T_2}{T_1} \Rightarrow \ln R = \frac{\ln(T_2) - \ln(T_1)}{\gamma - 1}$$

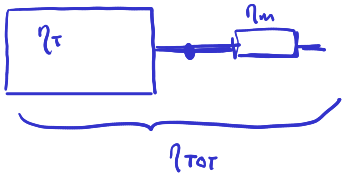
$$\ln R = \frac{\ln(300+273.15) - \ln(30+273.15)}{1.4 - 1} = \frac{0{,}6369}{0{,}4} = 1{,}59$$

$$\Rightarrow R = e^{1.59} = 4{,}91$$

$$\eta = 1 - \frac{1}{R^{\gamma-1}} = 1 - \frac{1}{(4.91)^{0.4}} = 0{,}471 = 47\%$$

Problema 7 $P = 50\,CV$ consume $8\,l/h$ $r = 8.5$ $H_c = 7800\,kcal/litro$ $\gamma = 1.4$





$\eta_{TOT} = \eta_T \cdot \eta_m$

Térmico

$$\eta_T = 1 - \frac{1}{R^{\gamma-1}} = 1 - \frac{1}{(8.5)^{0.4}} = 0{,}575 \quad \eta_T = 57{,}5\%$$

Total

$$\eta_{TOT} = \frac{P_u}{P_{consumida}} = \frac{50\,CV}{Q \cdot H_c}$$

(Q: caudal; H_c: poder calorífico)

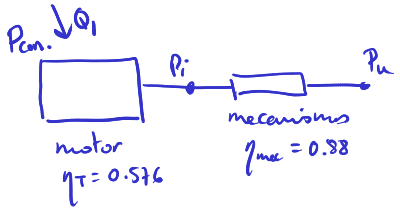
$$P_{consumida} = Q \cdot H_c = 8\,\frac{l}{h} \cdot 7800\,\frac{kcal}{l} \cdot \frac{4.192}{1\,cal} \cdot \frac{1\,h}{3600\,s} = 72{,}63\,kJ/s = 72{,}63\,kW$$

$$\eta_{TOT} = \frac{P_{útil}}{P_{cons}} = \frac{50\,CV}{72{,}63 \cdot 10^3\,W} \cdot \frac{735\,W}{1\,CV} = 0.506 \quad \eta_{TOTAL} = 50{,}6\%$$

$$\eta_{TOTAL} = \eta_T \cdot \eta_m \rightarrow \eta_m = \frac{\eta_{TOTAL}}{\eta_T} = \frac{0.506}{0.575} = 0.88 \rightarrow \eta_{mec} = 88\%$$

Problema 7, algo más.

Vemos algunos conceptos.



a) $P_{consumida}$, es la del calor Q_1

b) P_i, la de salida del motor térmico, que tiene que ver con el trabajo W que hace el motor } $\eta_T = \frac{P_i}{P_{cons.}}$

c) $P_{útil}$, la potencia útil aprovechable para mover el coche.

P_i es tb la potencia útil más la potencia que se disipa en los engranajes del coche.

$$\eta_{mec} = \frac{P_u}{P_i} = \frac{P_u}{P_u + P_{roz}}$$

$$\Rightarrow \quad P_{roz} = \frac{P_u - P_u \cdot \eta_{mec}}{\eta_{mec}} = P_u \cdot \frac{(1-\eta_{mec})}{\eta_{mec}} = 6{,}82\ CV = 5{,}01\ kW$$

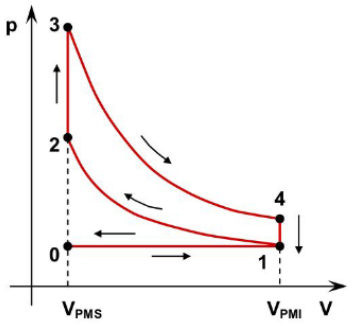
$$P_i = P_u + P_{roz} = 50\ CV + 6{,}82\ CV = 56{,}82\ CV = 41{,}76\ kW$$

$$\eta_{TOT} = \eta_T \cdot \eta_{mec} = \frac{P_i}{P_{cons}} \cdot \frac{P_u}{P_i} = \frac{P_i}{P_{cons.}} \cdot \frac{P_u}{P_u + P_{roz}}$$

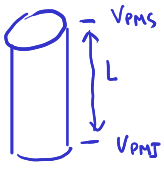
Problema 8

$V_{4c} = 1594\ cc$ (los 4 cilindros) y consume $Q = 7\ l/h$.

$r = 10:1$ $\quad L = 80\ mm = 8\ cm$



a) Calibre de pistones



$$V_c = \frac{V_{4c}}{4} = V_{PMI} - V_{PMS} = 398{,}5\ cc$$

$$V_c = L \cdot S = L \cdot \pi \left(\frac{\phi}{2}\right)^2 = \frac{L \pi \phi^2}{4}$$

$$\Rightarrow \quad \phi = \sqrt{\frac{4 V_c}{L \cdot \pi}} = \sqrt{\frac{4 \cdot 398.5\ cm^3}{8\ cm \cdot \pi}} = 7{,}96\ cm$$

$\phi \approx 8\ cm$

b) Calor consumido por hora.

$$\dot{Q}_{23} = m \cdot H_c = \rho \cdot V \cdot H_c = 0.75 \frac{kg}{dm^3} \cdot 7 \frac{l}{h} \cdot 9900 \frac{kcal}{kg} \cdot \frac{1\ dm^3}{1\ l} = 51975\ kcal/h$$

(por hora)

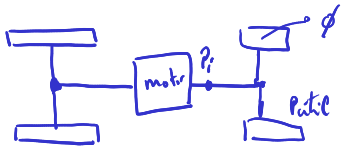
$$\dot{Q}_{23} = 51975 \frac{kcal}{h} \cdot \frac{1000\ cal}{1\ kcal} \cdot \frac{4{,}19\ J}{1\ cal} = 2{,}178 \cdot 10^8 \frac{J}{h} = 2.178 \cdot 10^8 \frac{J}{h} \cdot \frac{1\ h}{3600\ s} = 60{,}49\ kW$$

c) Potencia útil suministrada por el motor al coche. ($\eta_{TOTAL} = 30\%$)

$$\eta_{TOT} = 0.3 \qquad \eta_{TOTAL} = \frac{P_u}{P_{cons.}} \Rightarrow P_u = \eta_{TOTAL} \cdot P_{cons.} = 0.3 \cdot 60{,}49\ kW = 18{,}15\ kW$$

Problema 9

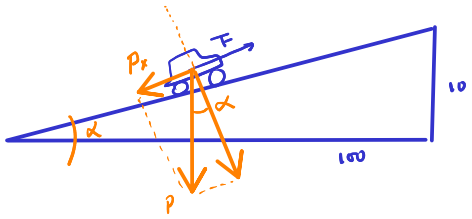
$P_i = 300\,CV$ a $3000\,rpm$ $\quad m = 10\,Tm = 1\cdot10^4\,kg$



$\eta_{mec} = 0.95$

¡Ojo! Me dan la potencia de salida del motor $P_i = 300\,CV$

a)



$\alpha = \arctan\left(\frac{10}{100}\right) = 5{,}71°$

Velocidad mínima de ascensión

Suponiendo que no hay rozamientos, la velocidad mínima se daría cuando $P_x = F$, la fuerza desarrollada por el motor sería igual a la componente x del peso.

$$F = P_x = m\cdot g\cdot \operatorname{sen}\alpha = 10^4\,kg\cdot 9{,}8\,m/s^2\cdot \operatorname{sen}(5{,}71°) = 9751{,}4\,N = 9{,}75\,kN$$

$$P = F\cdot v \Rightarrow v = \frac{P_{útil}}{F} = \frac{\eta_{mec}\cdot P_i}{F} = 0.95\cdot\frac{300\,CV}{9{,}75\cdot10^3\,N}\cdot\frac{735\,W}{1\,CV} = 21{,}48\,m/s$$

$$\eta_{mec} = \frac{P_{útil}}{P_i}$$

$$v = 21.48\,m/s\cdot\frac{3600\,s}{1\,h}\cdot\frac{1\,km}{1000\,m} = 77{,}34\,km/h$$

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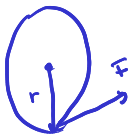
b) **Par motor en cada rueda.**

$$F_{rueda} = \frac{F}{4} = \frac{9{,}75\,kN}{4} = 2{,}44\,kN$$



$\phi = 80\,cm = 0{,}8\,m$

$$M = r\cdot F_{rueda} = \phi/2\cdot F_{rueda} = \frac{0.8\,m}{2}\cdot 2{,}44\,kN = 976\,N\,m$$

$M \simeq 980\,N\cdot m$

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c) **Relación de transmisión** Relación entre velocidades angulares del giro de la rueda y del motor (eje de transmisión).

1) Eje motor $\quad f_{motor} = 3000\,rpm \quad \omega_{motor} = 2\pi\cdot f = 2\pi\cdot 3000\,\frac{vuelt}{min}\cdot\frac{1\,min}{60\,s} = 314{,}16\,rad/s$

2) Rueda $\quad v = 21{,}48\,m/s = \omega_{rued}\cdot r = \omega_{rued}\cdot \phi/2 \Rightarrow \omega_{rueda} = \frac{2\cdot v}{\phi} = \frac{2\cdot 21.48\,m/s}{0.8\,m} = 53{,}7\,rad/s$

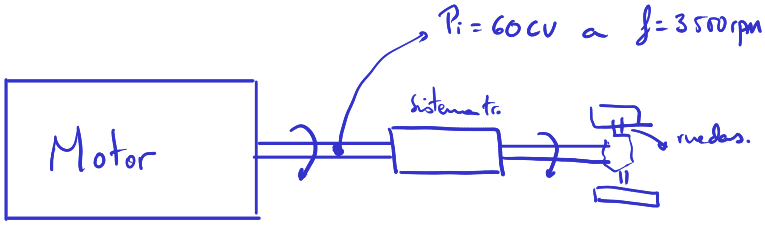
$$r = \frac{\omega_{motor}}{\omega_{rueda}} = \frac{314.16\,rad/s}{53{,}7\,rad/s} = 5.85$$

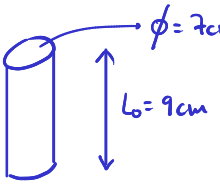
Se puede calcular de ambas formas; iguales, salvo decimales.

O también, $\quad P_u = M_{motor}\cdot\omega_{ruedas} \Rightarrow P_u = 4\cdot M_{rueda}\cdot\omega_{rueda}$

$$\omega_{rueda} = \frac{P_u}{4\cdot M_{rueda}} = \frac{\eta_{mec}\cdot P_i}{4\cdot 980\,N\cdot m} = \frac{0.95\cdot 300\,CV\cdot 735\,W/1\,c}{4\cdot 980\,Nm} = 53{,}44\,rad/s$$

Problema 10





$R = 9:1$

a) Cilindrada del motor.

$$R = \frac{V_{PMI}}{V_{PMS}} = 9 \qquad V_{PMI} - V_{PMS} = V_c = \pi\left(\frac{\phi}{2}\right)^2 \cdot L =$$

$$= \frac{\pi \phi^2 L}{4} = \frac{\pi \cdot (7cm)^2 \cdot 9cm}{4} = 346{,}36\,cc$$

Volumen de un cilindro es $V_c = 346.36\,cc$ y del motor $4V_c = 1385{,}44\,cc$.

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b) Volumen cámara de compresión. V_{PMS}

$$\frac{V_{PMI}}{V_{PMS}} = R \qquad V_{PMI} - V_{PMS} = V_c \Rightarrow R \cdot V_{PMS} - V_{PMS} = V_c \Rightarrow V_{PMS}(R-1) = V_c \Rightarrow V_{PMS} = \frac{V_c}{R-1}$$

$$V_{PMS} = \frac{V_c}{R-1} = \frac{346.36\,cc}{9-1} = 43.3\,cc$$

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c) Par motor "n" frecuencia en rpm

$$P_i = \frac{M \cdot \pi \cdot n}{30} \Rightarrow M = \frac{30 \cdot P}{\pi \cdot n} = \frac{30 \cdot 60\,CV \cdot 735\,W/1\,CV}{\pi \cdot 3500\,rpm} = 120.32\,N \cdot m$$

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d) Rendimiento si consume $\dot{m} = 8\,kg/h$ $\quad H_c = 11000\,kcal/kg$

$$P_{consumida} = \dot{m} \cdot H_c = \frac{8\,kg}{h} \cdot \frac{1h}{3600s} \cdot \frac{11000 \cdot 10^3\,cal}{kg} \cdot \frac{4.19\,J}{1\,cal} = 1{,}02 \cdot 10^5\,W$$

$$P_i = 60\,CV \cdot \frac{735\,W}{1\,CV} = 4{,}41 \cdot 10^4\,W$$

$$\Rightarrow \eta_T = \frac{P_i}{P_{cons.}} = \frac{4.41 \cdot 10^4\,W}{1.02 \cdot 10^5\,W} = 0{,}432 = 43.2\,\%$$

$$\eta = 1 - \frac{1}{R^{\gamma-1}} \Rightarrow \frac{1}{R^{\gamma-1}} = 1 - \eta \qquad R^{\gamma-1} = \frac{1}{1-\eta} \qquad (\gamma-1)\ln R = \ln\left(\frac{1}{1-\eta}\right)$$

$$\gamma - 1 = \frac{\ln(1/1-\eta)}{\ln R}$$

No lo piden, pero.

$$\gamma = \frac{\ln(1/1-\eta)}{\ln R} + 1 = 1.257$$ Coef. adiabático.