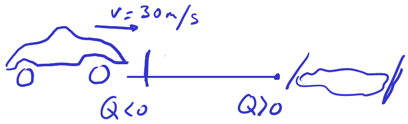
Problema 9

Las gotas de agua cayendo hacen un trabajo contra el sistema $W<0$

Suponiendo que la t's de las gotas y del mar es casi la misma, no hay trasvase de calor $Q \approx 0$, luego $\Delta U = Q - W = |W|$. El mar sólo puede aumentar su tª

Problema 10

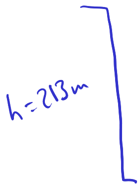


$$Q = \Delta E_c = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2 = -\frac{1}{2} 1000\,kg \cdot (30\,m/s)^2 = 4{,}5 \cdot 10^5\ J \cdot \frac{1\,cal}{4{,}19\,J} = 1{,}07 \cdot 10^5\,cal = 107{,}4\ kcal$$

$$Q = m \cdot c \cdot \Delta T \Rightarrow \Delta T = \frac{Q}{m \cdot c} = \frac{Q}{\rho \cdot V \cdot c} = \frac{107{,}4 \cdot 10^3\ \cancel{cal}}{1\,\frac{\cancel{kg}}{\cancel{\ell}} \cdot 1\,\cancel{m^3} \cdot \frac{10^3\,\cancel{dm^3}}{1\,\cancel{m^3}} \cdot \frac{1\,\cancel{\ell}}{1\,\cancel{dm^3}} \cdot \frac{1\,\cancel{cal}}{\cancel{g}\,°C} \cdot \frac{1000\,\cancel{g}}{1\,\cancel{kg}}} =$$

$$\Delta T = \frac{107{,}4 \cdot \cancel{10^3}}{10^3 \cdot \cancel{10^3}}\ °C = 0{,}1074\,°C$$

Problema 11



$$\Delta E_p = Q \qquad m \cdot g \cdot h = m \cdot c \cdot \Delta T$$

$$g \cdot h = c \cdot \Delta T$$

$$c = \frac{g \cdot h}{\Delta T} = \frac{9{,}8\,m/s^2 \cdot 213\,m}{0{,}5\,°C} = 4175\ \frac{m^2/s^2}{°C} \quad J/kg$$

$$c = \frac{1\,cal}{g\,°C} = \frac{4175\ J/kg}{°C} = \frac{4175\ J}{10^3 g\ °C} = 4{,}175\ \frac{J}{g\,°C}$$

$$\Rightarrow 1\,cal = 4{,}175\,J$$

Problema 12

$$\Delta E_c = Q \qquad \frac{1}{2} m v^2 = m \cdot c \cdot \Delta T$$

$$\Delta T = \frac{v^2}{2 \cdot c} = \frac{(15\,m/s)^2}{2 \cdot \frac{1\,cal}{g\,°C}} = \frac{225\ J/kg}{2\ cal/g\,°C} = \frac{0{,}225\ J/\cancel{g}}{2\ cal/\cancel{g}}\ °C$$

$$\Delta T = \frac{0{,}225\ \cancel{J}}{2\,\cancel{cal}} \cdot \frac{1\,\cancel{cal}}{4{,}19\,\cancel{J}}\ °C = 0{,}027\,°C$$

Problema 13

Sí, siempre es posible, pero en contrapartida otro sistema debe aumentar su entropía mucho más para que el balance cumpla $\Delta S > 0$

Problema 14

a) $m = 1\,kg \quad L = 500\,kcal/kg$

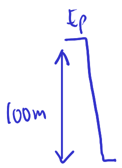
$$Q = m \cdot L = 1\,kg \cdot 500\,kcal/kg = 500\,kcal = 5 \cdot 10^5\,cal \cdot \frac{4{,}19\,J}{1\,cal} = 2{,}095 \cdot 10^6\,J.$$

b) $E_p = m \cdot g \cdot h = 4000\,kg \cdot 9{,}8\,m/s^2 \cdot 40\,m = 1{,}568 \cdot 10^6\,J.$

$W_u = E_p.$

$$\eta = \frac{W_u}{W_m} = \frac{1{,}568 \cdot 10^6\,J}{2{,}095 \cdot 10^6\,J} = 0{,}748 = 74{,}8\ \%$$

Problema 15



$$\Delta E_p = mgh = Q = m \cdot c \cdot \Delta T$$

$$\Delta T = gh/c = \frac{9{,}8\,m/s^2 \cdot 100\,m}{1\,cal/g\,°C} = \frac{980\,J/kg}{1\,cal/g\,°C} = \frac{980\,J/kg}{4{,}19 \cdot 10^3\,J/kg} °C = 0{,}234\,°C$$

$$c = 1\,cal/g\,°C = 1\,\cancel{cal} \cdot \frac{4{,}19\,J}{1\,\cancel{cal}} \cdot \frac{1}{\cancel{g}} \cdot \frac{1000\,\cancel{g}}{1\,kg} \cdot \frac{1}{°C} = 4{,}19 \cdot 10^3\,J/kg \cdot °C$$

Problema 16

$\eta = 30\% \qquad L_c = 10^4\,cal/g \qquad Q_c = m \cdot L_c = 500\,g \cdot 10^4\,cal/g = 5 \cdot 10^6\,cal/g$

$$\eta = \frac{W_u}{Q} \Rightarrow W_u = \eta \cdot Q_c = 0{,}3 \cdot 5 \cdot 10^6\,cal/g = 1{,}5 \cdot 10^6\,cal/g \cdot \frac{4{,}19\,J}{1\,cal} = 6{,}285 \cdot 10^6\,J$$

Problema 17

$m = 100\,kg \qquad L = 9000\,kcal/kg = 9 \cdot 10^6\,cal/kg \quad y \quad \eta = 0{,}4$

$$W_u = \eta \cdot Q = 0{,}4 \cdot 100\,\cancel{kg} \cdot 9 \cdot 10^6\,cal/\cancel{kg} = 3{,}6 \cdot 10^8\,cal = 3{,}6 \cdot 10^8\,cal \cdot \frac{4{,}19\,J}{cal} = 1{,}51 \cdot 10^9\,J$$

Problema 18

$m = 1000\,kg \qquad \eta = 20\% \qquad L_c = 10^4\,cal/g \qquad v_f = 36\,\cancel{km}/\cancel{h} \cdot \frac{1\,\cancel{h}}{3600\,s} \cdot \frac{1000\,m}{1\,\cancel{km}} = 10\,m/s$

a) $\Delta E_c = \frac{1}{2} m v_f^2 - \underbrace{\cancel{\frac{1}{2} m v_i^2}}_{reposo}{}^{\to 0} = \frac{1}{2} 1000\,kg \cdot (10\,m/s)^2 = 5 \cdot 10^6\,J = W_u$

b) $\eta = \frac{W_u}{Q} \Rightarrow Q = \frac{W_u}{\eta} = \frac{5 \cdot 10^4\,J}{0{,}2} = 2{,}5 \cdot 10^5\,J \cdot \frac{1\,cal}{4{,}19\,J} = 5{,}966 \cdot 10^4\,cal$

c) $Q = m \cdot L_c \Rightarrow m = Q/L_c = \frac{5{,}966 \cdot 10^4\,cal}{10^4\,cal/g} \simeq 6\,g$

Problema 19

$Q = 938\ kcal$

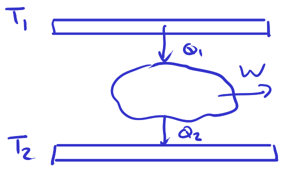
$\eta = 15\%$

$$\eta = W_u/Q \Rightarrow W_u = \eta \cdot Q = 0{,}15 \cdot 938\ kcal = 140{,}7\ kcal = 5{,}895 \cdot 10^5\ J$$

Si ese trabajo útil lo utiliza para subir una montaña...

$$W_u = \Delta E_p = m \cdot g \cdot h \Rightarrow h = \frac{W_u}{m \cdot g} = \frac{5{,}895 \cdot 10^5\ J}{60\ kg \cdot 9{,}8\ m/s^2} = 1002{,}6\ m \simeq 1000\ m$$

Problema 20.



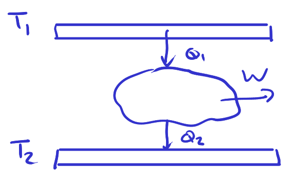
$$\eta = \frac{|Q_1| - |Q_2|}{|Q_1|} = 1 - \frac{|Q_2|}{|Q_1|} = 1 - \frac{T_2}{T_1}$$

↓ ideal

$$\eta_{antes} = 1 - \frac{T_2}{T_1} = 1 - \frac{(27 + 273.15)\ K}{(227 + 273.15)\ K} = 0{,}4 \simeq 40\%$$

$$\eta_{ahora} = 1 - \frac{T_2}{T_1} = 1 - \frac{(27 + 273.15)\ K}{(327 + 273.15)\ K} = 0{,}5 \simeq 50\%$$

Problema 21



$T_2 = 7°C \qquad \eta = 40\% \rightarrow T_1$

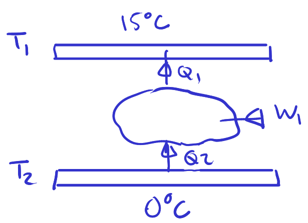
a) $$\eta = 1 - \frac{T_2}{T_1} \qquad \frac{T_2}{T_1} = 1 - \eta \rightarrow T_1 = \frac{T_2}{1-\eta} = \frac{(7 + 273.15)\ K}{1 - 0{,}4}$$

$$T_1 = 467\ K = 193{,}77°C$$

b) $$T_1^* = \frac{T_2}{1 - \eta^*} = \frac{(7 + 273.15)\ K}{1 - 0{,}5} = 560{,}3\ K = 287{,}15\ °C$$

$$\Delta T = T_1^* - T_1 = 287{,}15°C - 193{,}77°C = 93{,}38\ °C$$

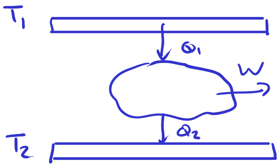
Problema 22



$$\varepsilon = \frac{|Q_2|}{W} = \frac{|Q_2|}{|Q_1| - |Q_2|} = \frac{1}{\frac{|Q_1|}{|Q_2|} - 1} = \frac{1}{\frac{T_1}{T_2} - 1} =$$

$$= \frac{1}{\frac{(15 + 273.15)\ K}{(0 + 273.15)\ K} - 1} = \frac{1}{1{,}054 - 1} = 18{,}39$$

Problema 23



$$\eta = 1 - \frac{T_2}{T_1} = 0.2 \longrightarrow T_2/T_1 = 1 - 0.2 = 0.8$$

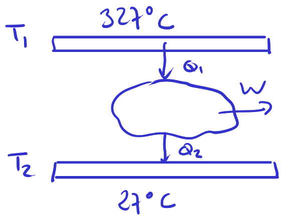
$$\eta^* = 1 - \frac{(T_2 - 73)}{T_1} = 0.4 \rightarrow \frac{T_2 - 73}{T_1} = 1 - 0.4 = 0.6$$

en variación $\Delta T = 73°C = 73\,k$

$$\frac{T_2 - 73}{T_1} = 0.6 \Rightarrow \frac{T_2}{T_1} - \frac{73k}{T_1} = 0.6 \Rightarrow 0.8 - \frac{73k}{T_1} = 0.6 \Rightarrow \frac{73k}{T_1} = 0.2$$

$$T_1 = \frac{73\,k}{0.2} = 365\,k = 91{,}85\,°C \qquad T_2 = T_1 \cdot 0{,}8 = 292\,k = 18{,}85\,°C$$

Problema 24



$W = 7000\,cal. = |Q_1| - |Q_2|$

$$\eta = \frac{W}{|Q_1|} = 1 - \frac{T_2}{T_1} = 1 - \frac{(27+273.15)k}{(327+273.15)k} = 1 - 0.5 = 0.5 = 50\%.$$

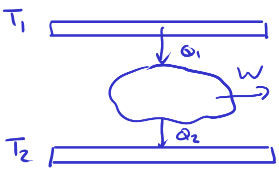
$$\Rightarrow |Q_1| = \frac{W}{\eta} = \frac{7000\,cal}{0{,}5} = 14\,000\,cal$$

$|Q_2| = 7000\,cal$ (calor cedido, negativo) $Q_2 = -7000\,cal$

Problema 25

Es evidente que los gases de la coca-cola se expanden con muy poco gasto energético, comparado con el gasto energético necesario para confinar los gases en la botella. La probabilidad de que los gases se vuelvan a confinar en la botella espontáneamente es casi nula. La entropía pues ha aumentado mucho.

Problema 26.



$\eta = 0.3 \qquad |Q_1| = 150\ cal/ciclo$

$$\eta = W/|Q_1| \Rightarrow W = \eta \cdot |Q_1| = 0.3 \cdot 150\ cal/ciclo =$$

$$= 45\ cal/ciclo = 188{,}55\ J/ciclo.$$

$$W = |Q_1| - |Q_2| \Rightarrow |Q_2| = |Q_1| - W = 150\,cal/ciclo - 45\,cal/ciclo =$$

$$|Q_2| = 105\ cal/ciclo$$

$$Q_2 = -105\ cal$$