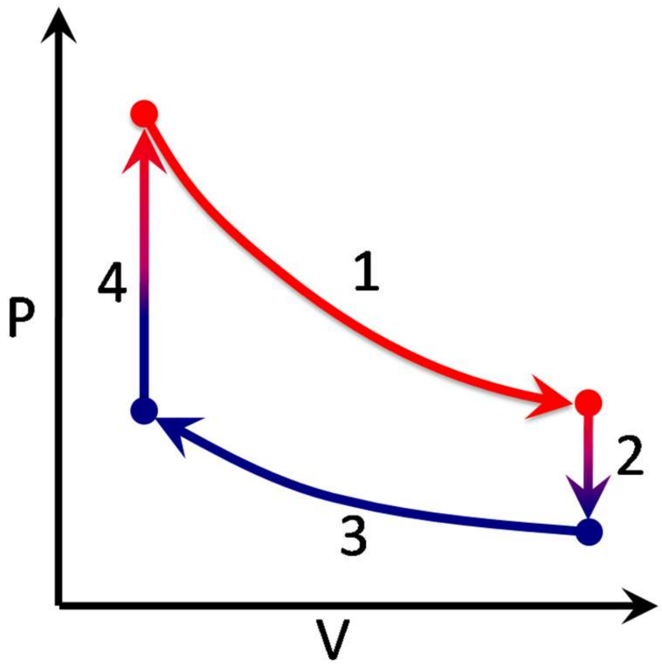


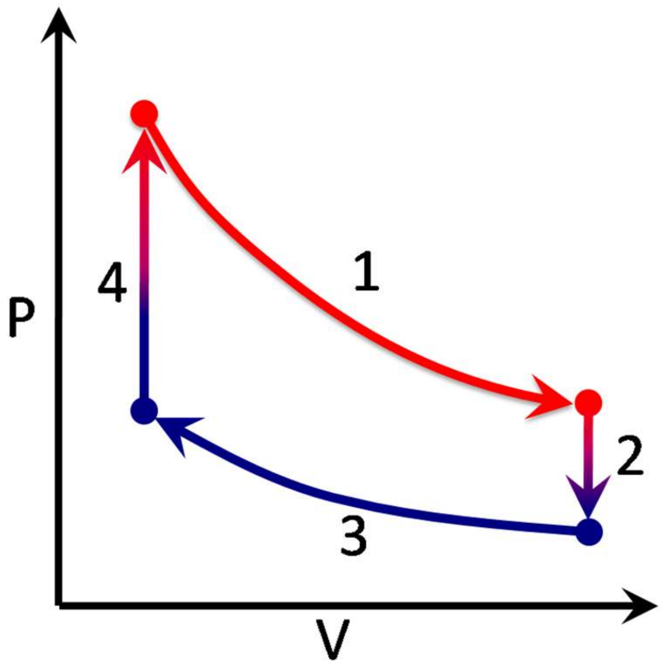
Around a full cycle, we can say that the net heat flow $Q_H + Q_C$ is

A) greater than the net work W

B) equal to the net work W

C) less than the net work W

D) Any of the above are possible, depending on the cycle



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A) greater than the net work W

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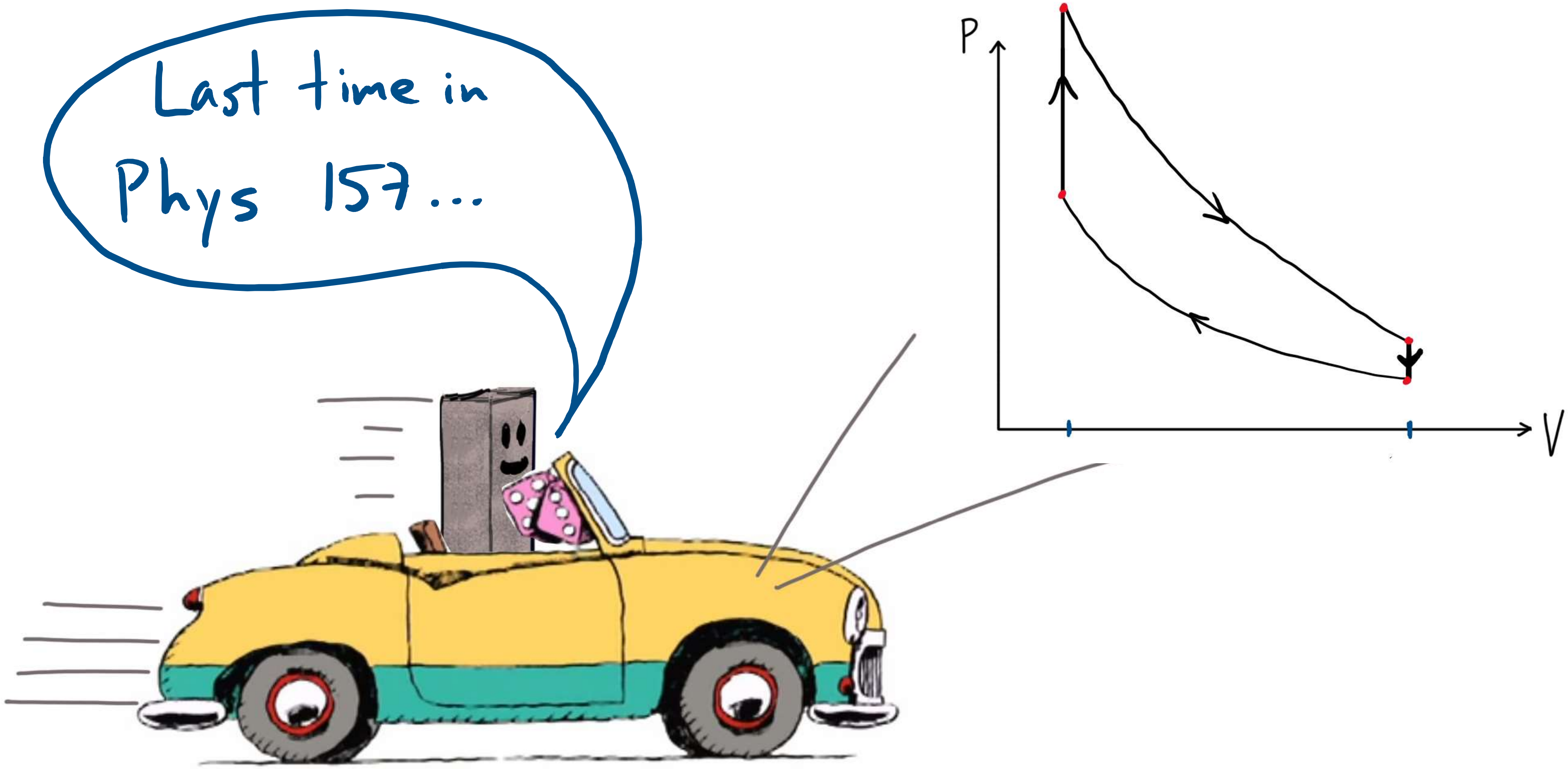
$\Delta U = 0$ for full cycle

so $Q = W$


Last time in Phys 157...
P
V

What are you trying to calculate? n: use $PV = nRT$

T, V, or P: use $\frac{PV}{T} = \text{const}$

adiabatic: also have $TV^{\gamma-1} = \text{const}$

$PV^{\gamma} = \text{const}$

ΔU: have $\Delta U = nC_v \Delta T$ always

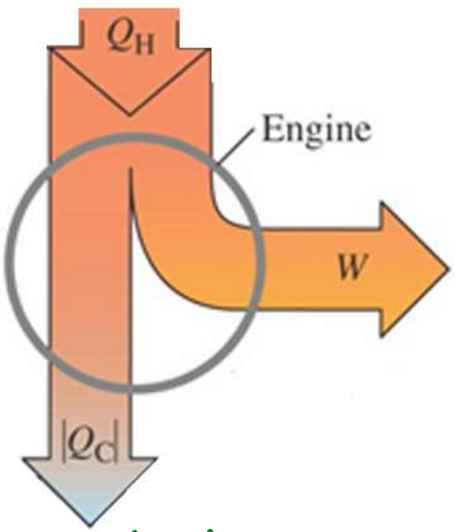
W or Q: have $W = P\Delta V$ const P

$W = nRT \ln\left(\frac{V_f}{V_i}\right)$ const T

all others: use $Q = \Delta U + W$

(gives $Q = nC_p \Delta T$ const P)

Efficiency of an Engine



Q_H : Heat absorbed by gas each cycle

Q_C : Heat expelled by gas

W : Net work done each cycle

$Q_H = |Q_C| + W$

Efficiency is: $e = \dfrac{W}{Q_H}$ ← work we get out / ← heat we need to supply

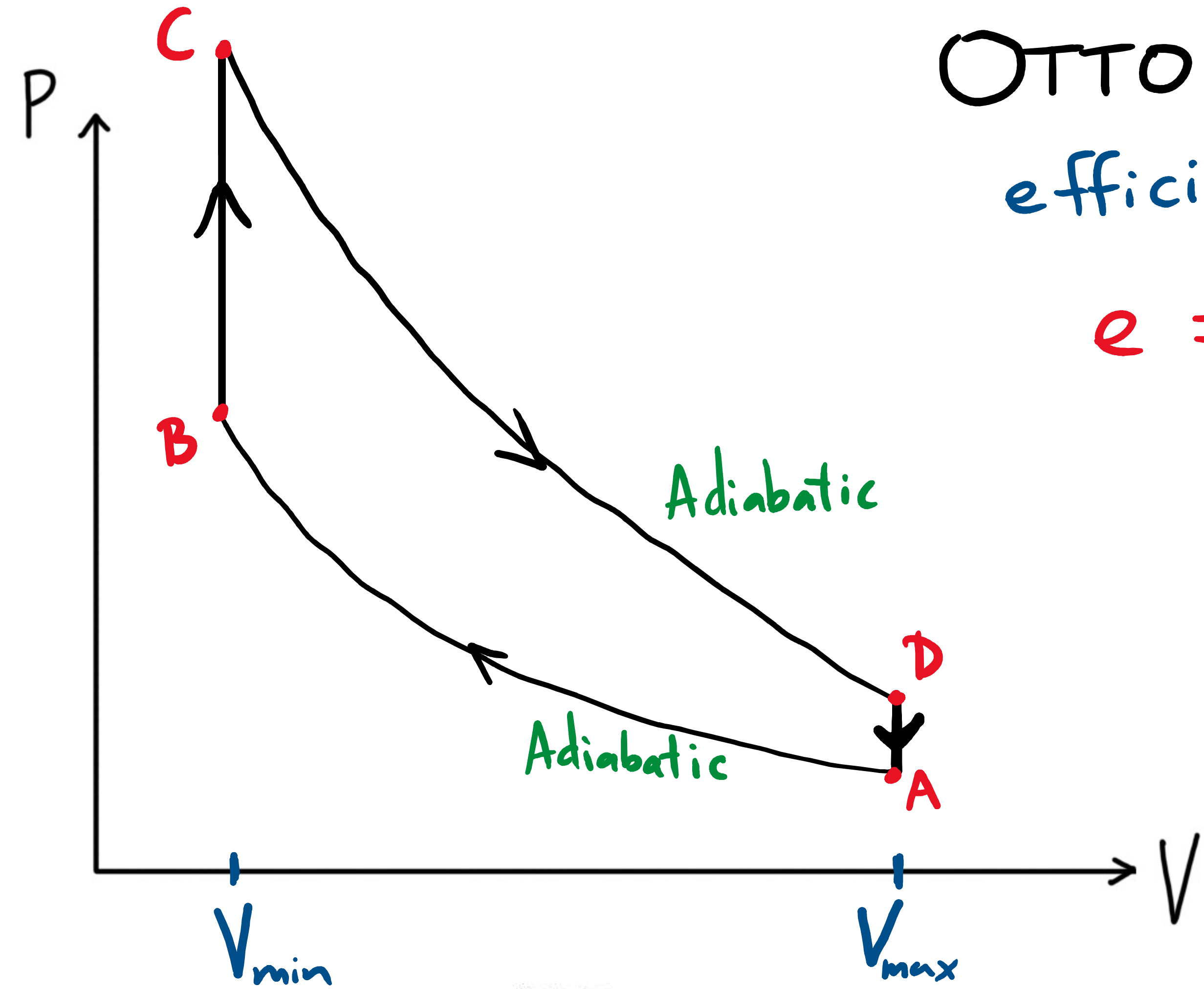
$$= 1 - \frac{|Q_C|}{Q_H}$$

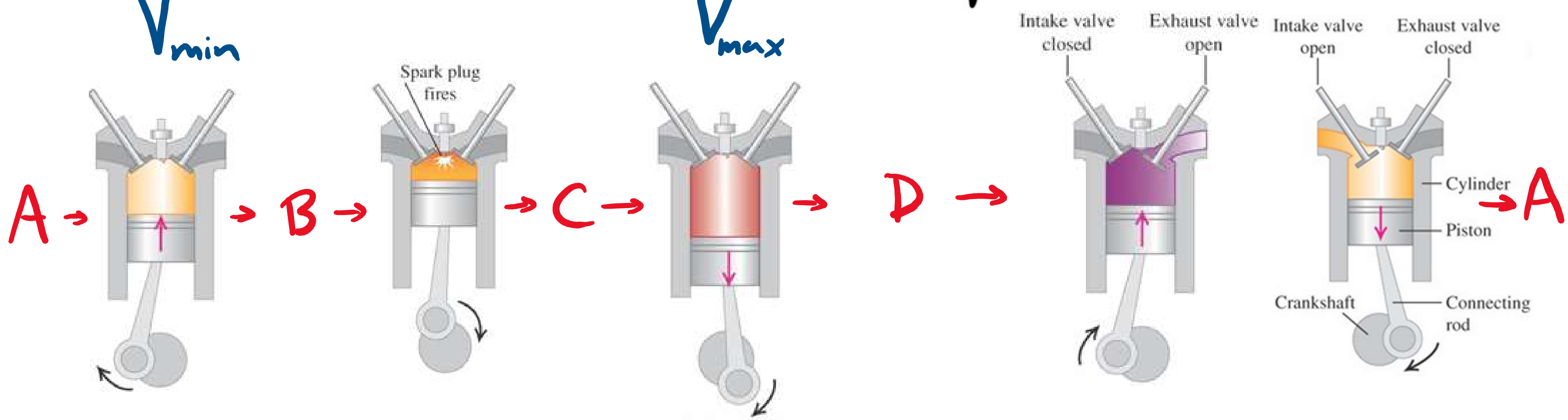
OTTO CYCLE:

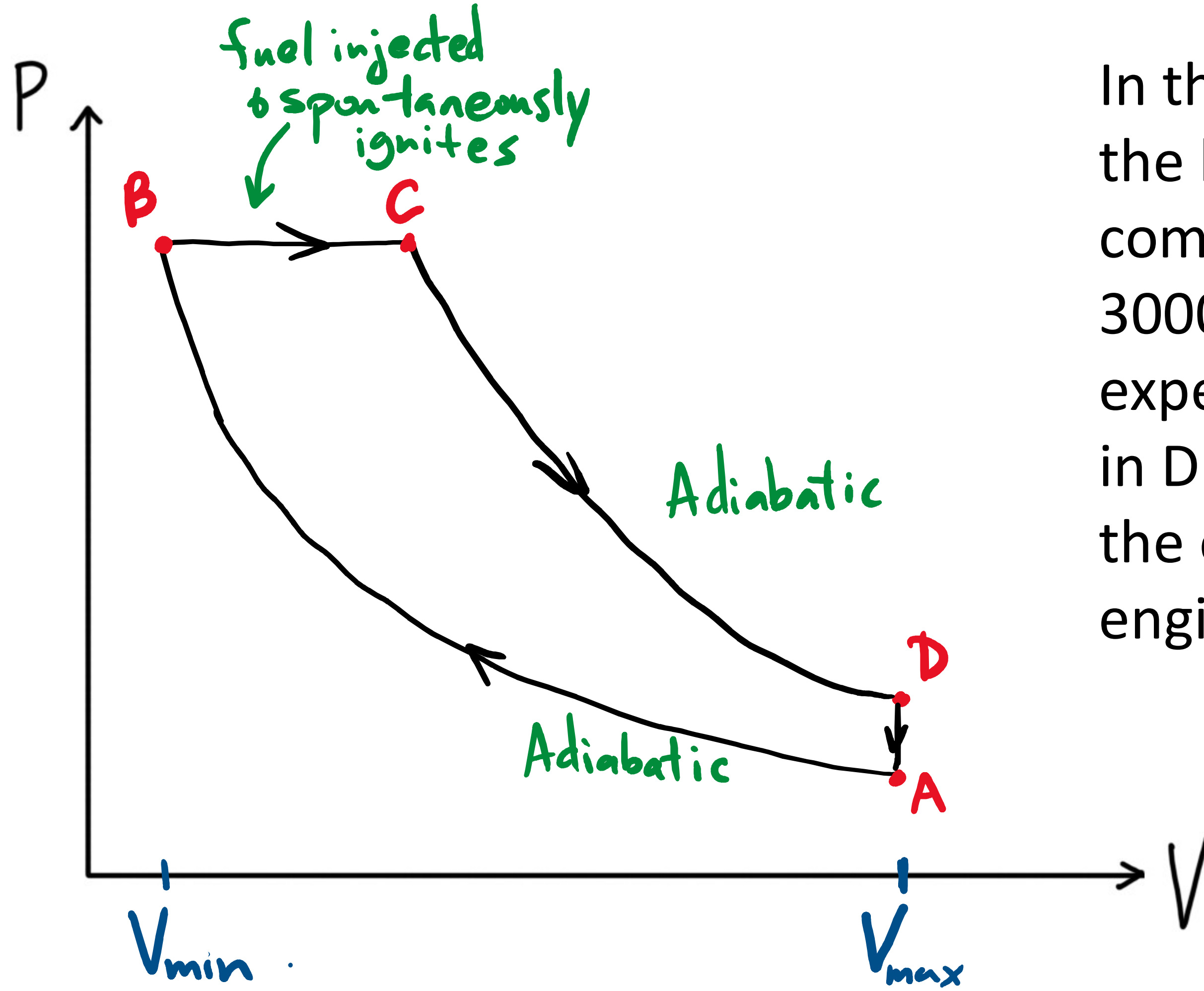
efficiency

$$e = 1 - \frac{1}{r^{\gamma - 1}}$$

compression ratio V_{max}/V_{min}



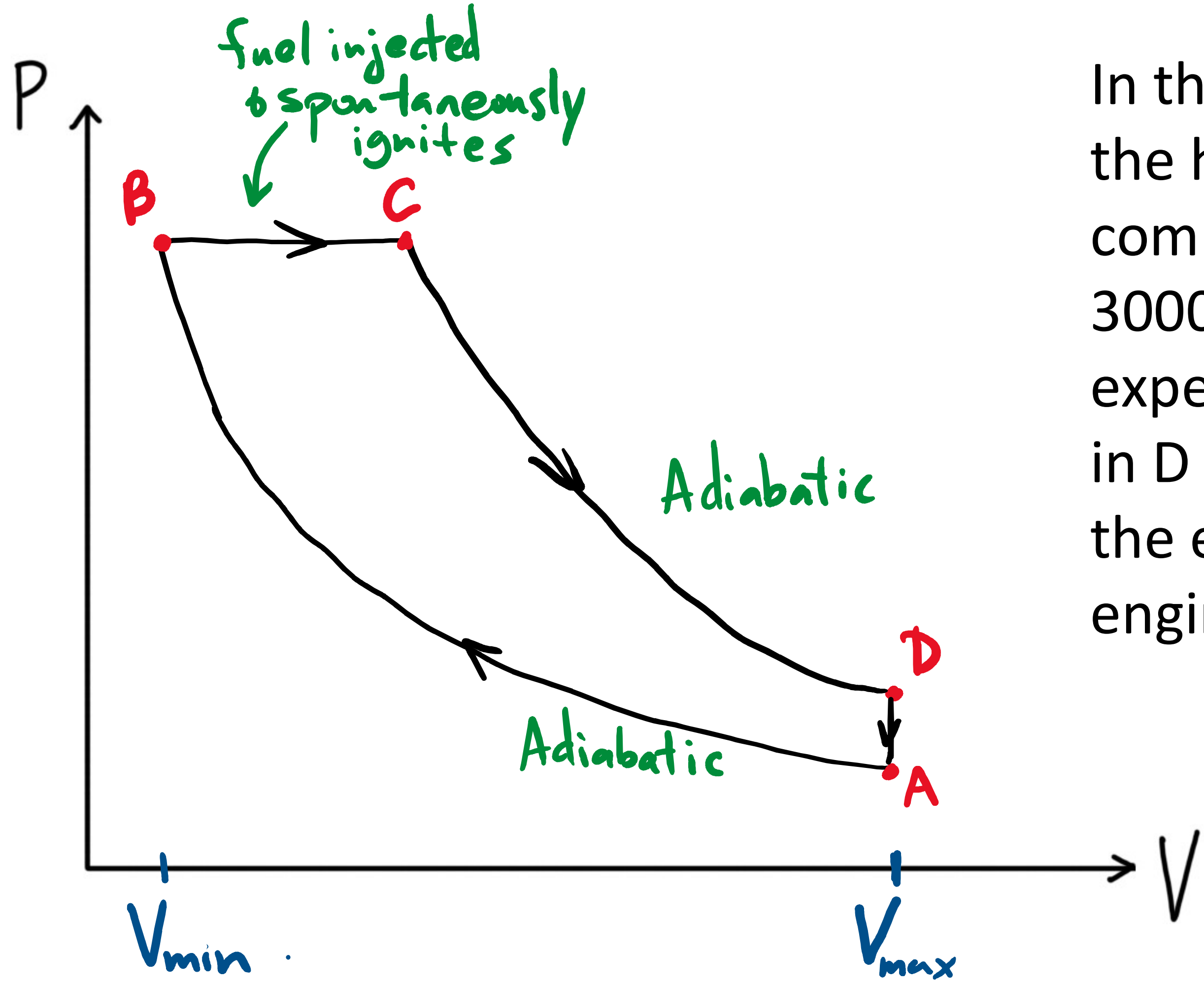




In the Diesel cycle shown, the heat added from combustion in B -> C is 3000J while the heat expelled from the cylinder in D -> A is 1800J. What is the efficiency of the engine?

A) 0.375 B) 0.400 C) 0.600

D) 0.666 E) 0.866



In the Diesel cycle shown, the heat added from combustion in B -> C is 3000J while the heat expelled from the cylinder in D -> A is 1800J. What is the efficiency of the engine?

$W_{net} = Q_{net}$

$= 3000J - 1800J$

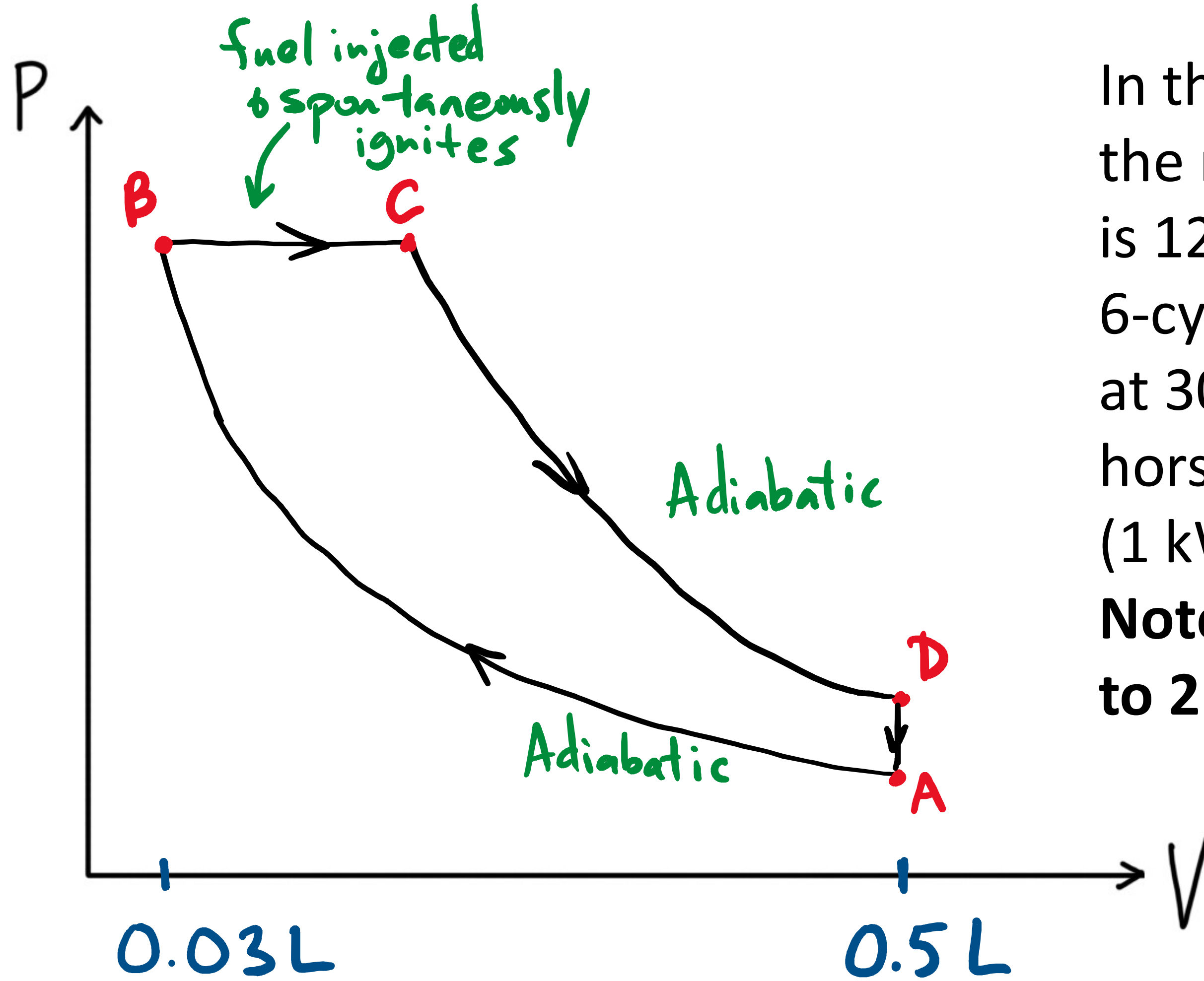
$= 1200J$

$Q_{in} = 3000J$

$e = \frac{1200}{3000} = 0.4$

A) 0.375 B) 0.400 C) 0.600

D) 0.666 E) 0.866



In the Diesel cycle shown, the net work done per cycle is 1200J. If a car with a 6-cylinder engine is running at 3000rpm, how many horsepower is the engine? (1 kW = 1.33hp)

Note: 1 cycle corresponds to 2 revolutions

Have

$6 \times \frac{1500}{60} = 150$ cycles per second

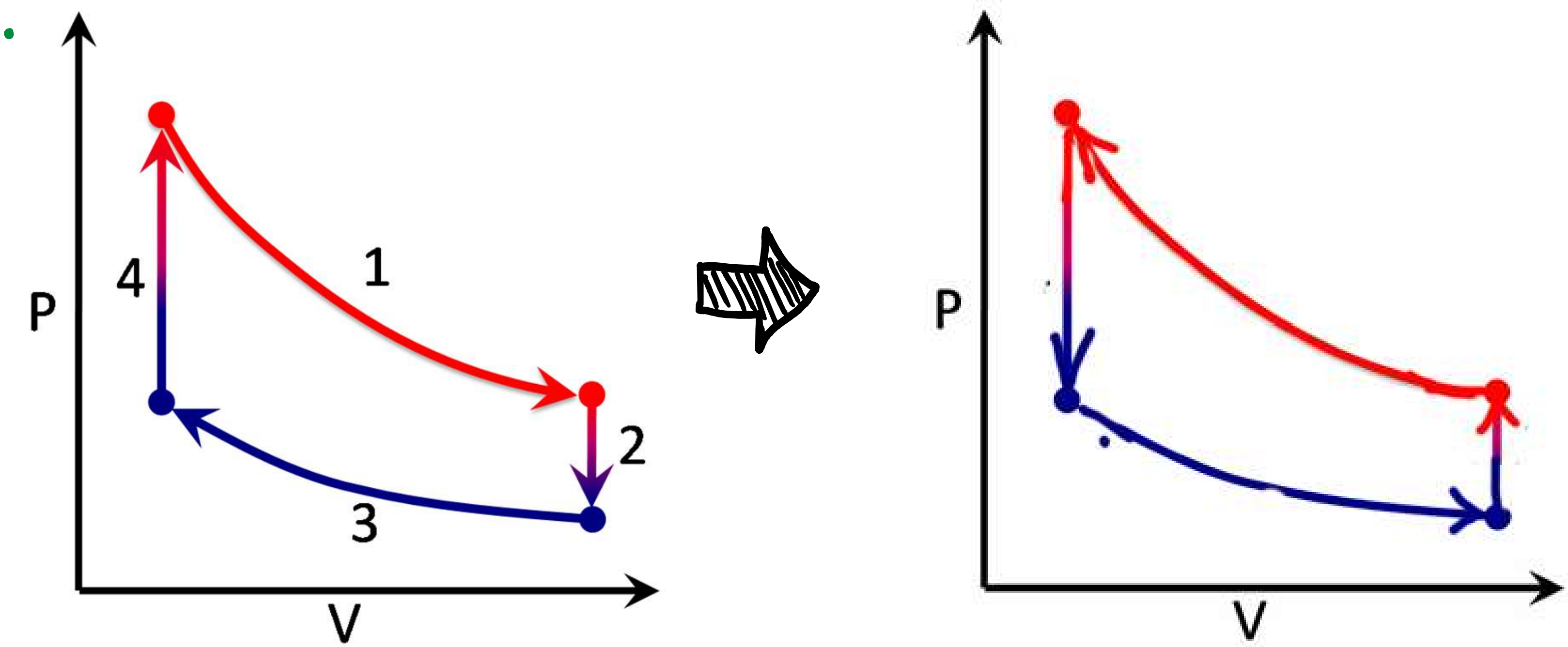
so $150 \times 1200J = 180{,}000 J/s = 240hp$

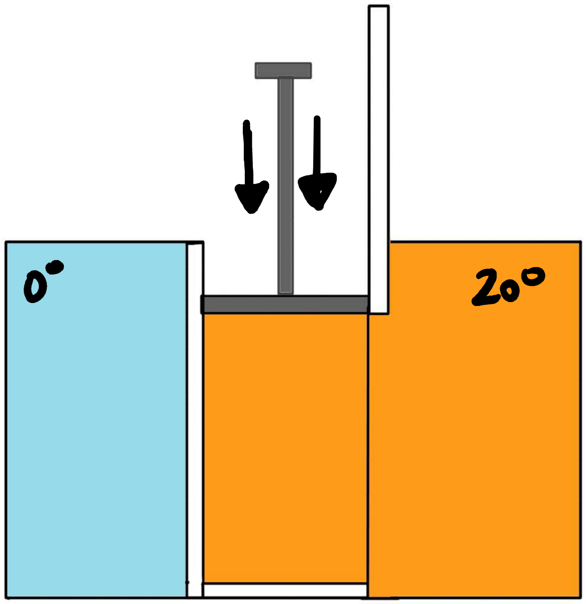
A) 120 B) 160 C) 200 D) 240 E) 300

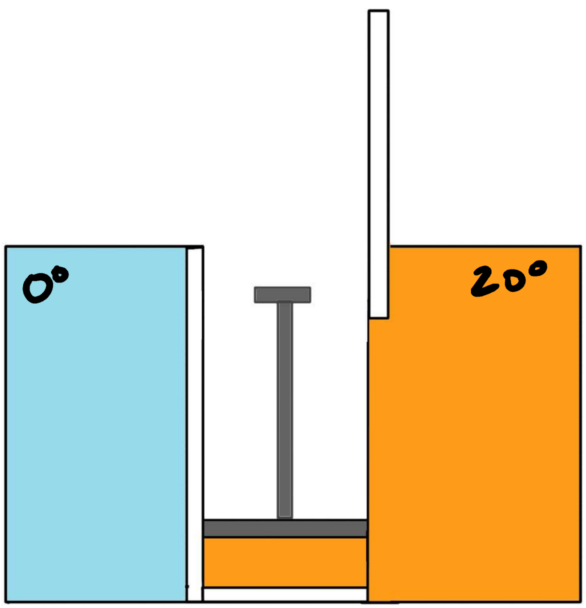
REFRIGERATORS: Can transfer heat from colder system to warmer system by doing work.

☆ Heat engine in reverse ☆

e.g.







1 mole of nitrogen gas ($C_V = 5/2\ R$) is compressed at constant temperature T = 20 °C from 20L to 5L.

Does heat flow in or out of the gas?

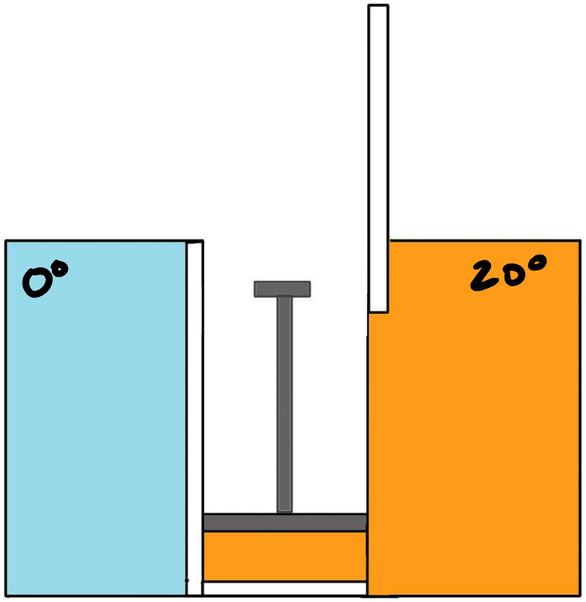
What is Q for this process?

isothermal: $\Delta U = 0$

$$Q = W = nRT \ln\left(\frac{V_f}{V_i}\right)$$

$$= -3145\,J$$

heat goes out



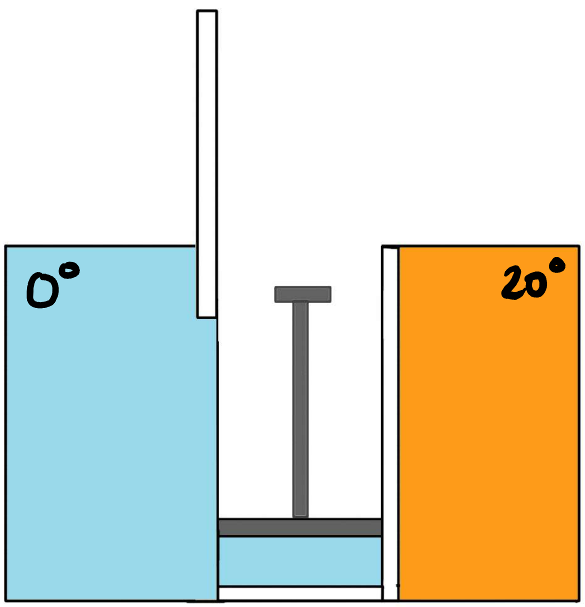
The gas is now insulated from the warm system and put in thermal contact with the cold system, so that it cool from T = 20 ºC to T = 0 ºC at constant volume 5L.

What is Q for this process?

const V: $W = 0$

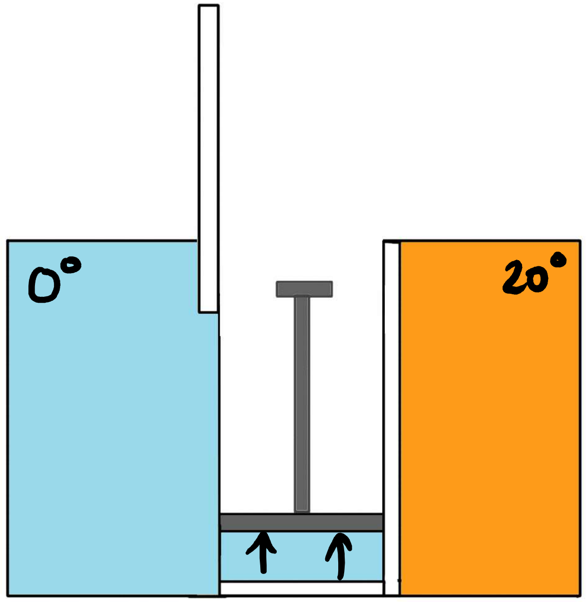
$$Q = \Delta U = nC_v \Delta T$$

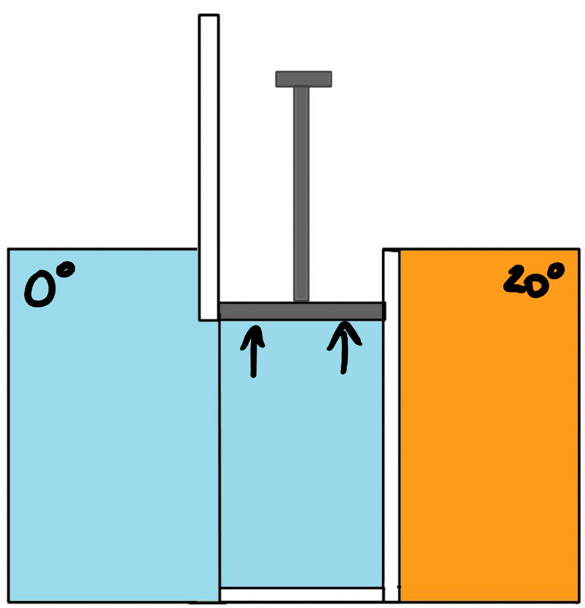
$$= -416\,J$$



What is the pressure of the gas now?
(recall n = 1 mole)

use $P = \frac{nRT}{V} \approx 454\,kPa$





The gas is now allowed to expand at constant temperature from 5L back to 20L.

Does heat flow in or out of the gas?

What is Q for this process?

const T: $\Delta U = 0$

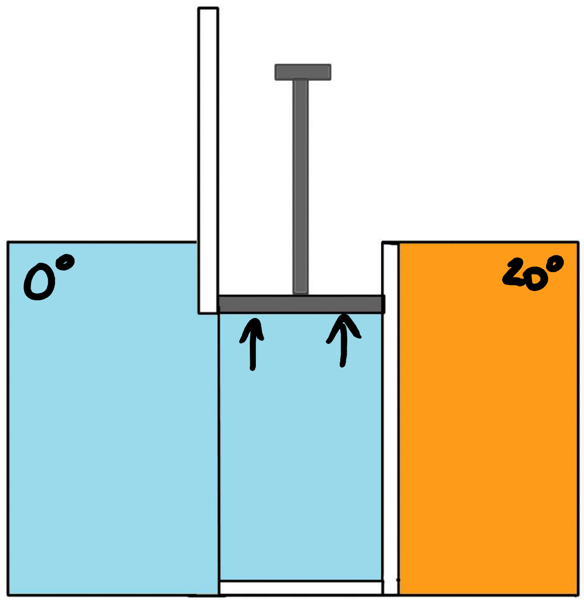
$$Q = W = nRT \ln\left(\frac{V_f}{V_i}\right)$$

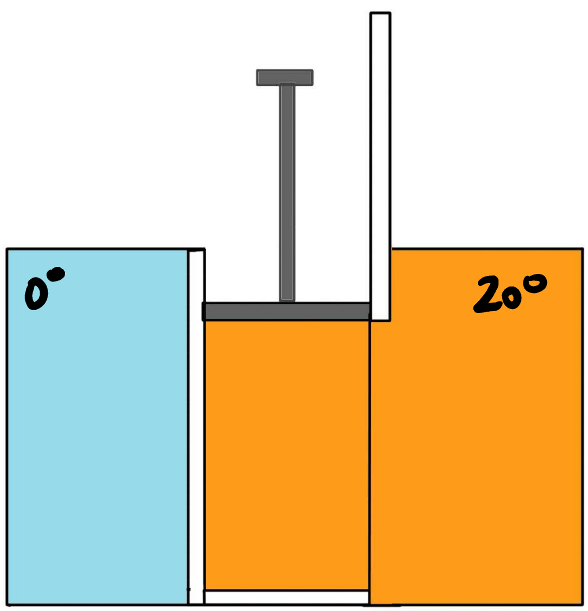
$$= 3375 \text{ J}$$

What is the final pressure?

$$P_f V_f = P_i V_i$$

$$P_f = \frac{1}{4} P_i \approx 113 \text{ kPa}$$





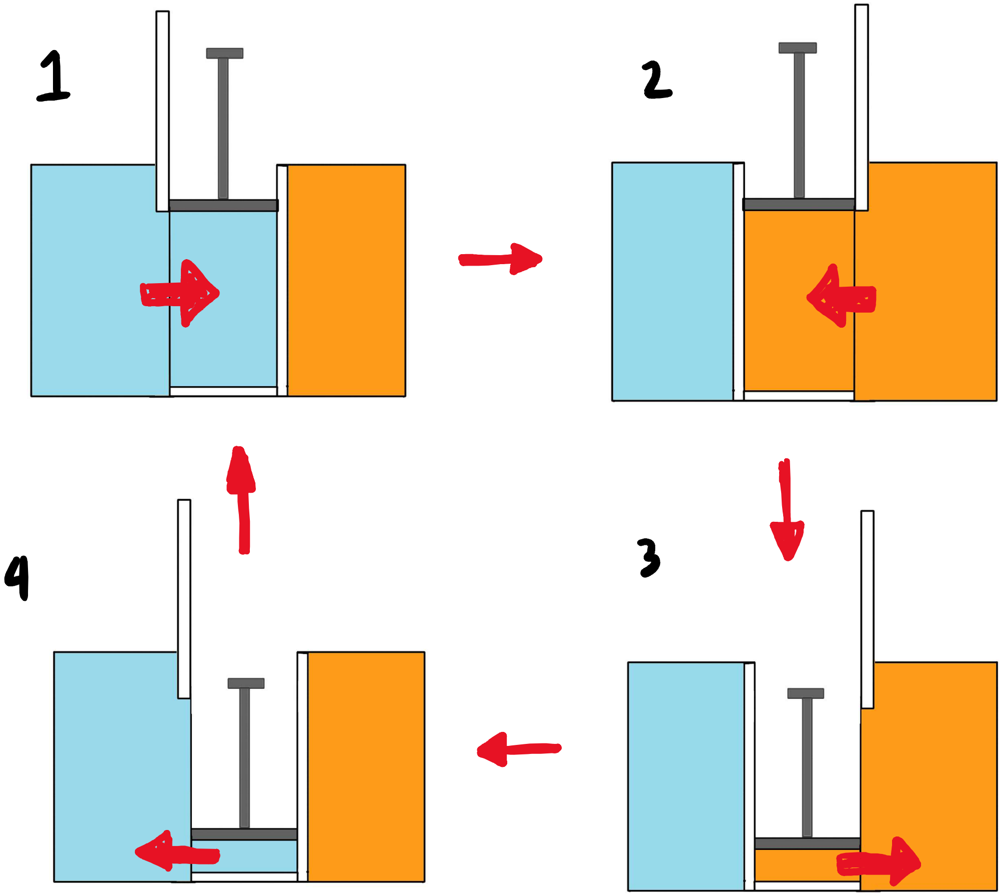
Finally, the gas is insulated from the cold system and put in thermal contact with the warm system, so that it warms at constant volume 20L from T = 0 ºC to T = 20 ºC.

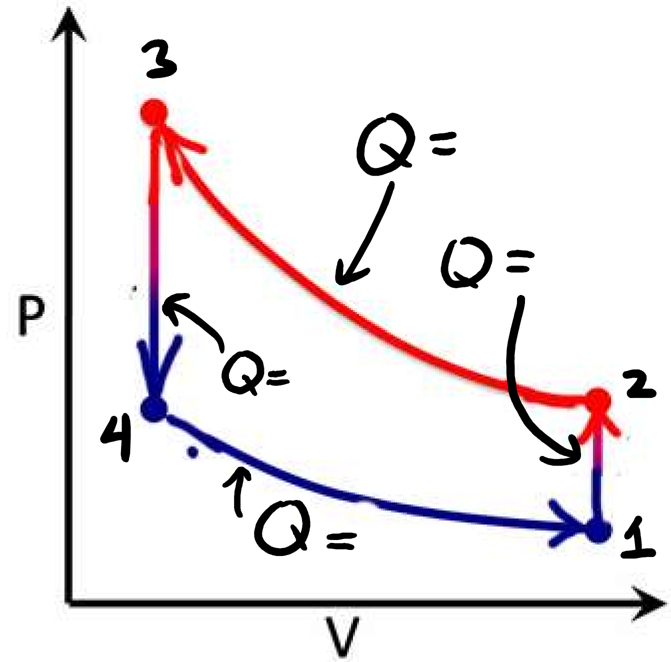
What is Q for this process?

const Vol: $W = 0$

$$Q = \Delta U = n C_v \Delta T$$

$$= 416 \text{ J}$$





net Q out of cold system: 2729 J

net Q for gas: 230 J

net work done: 230 J