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

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

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

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

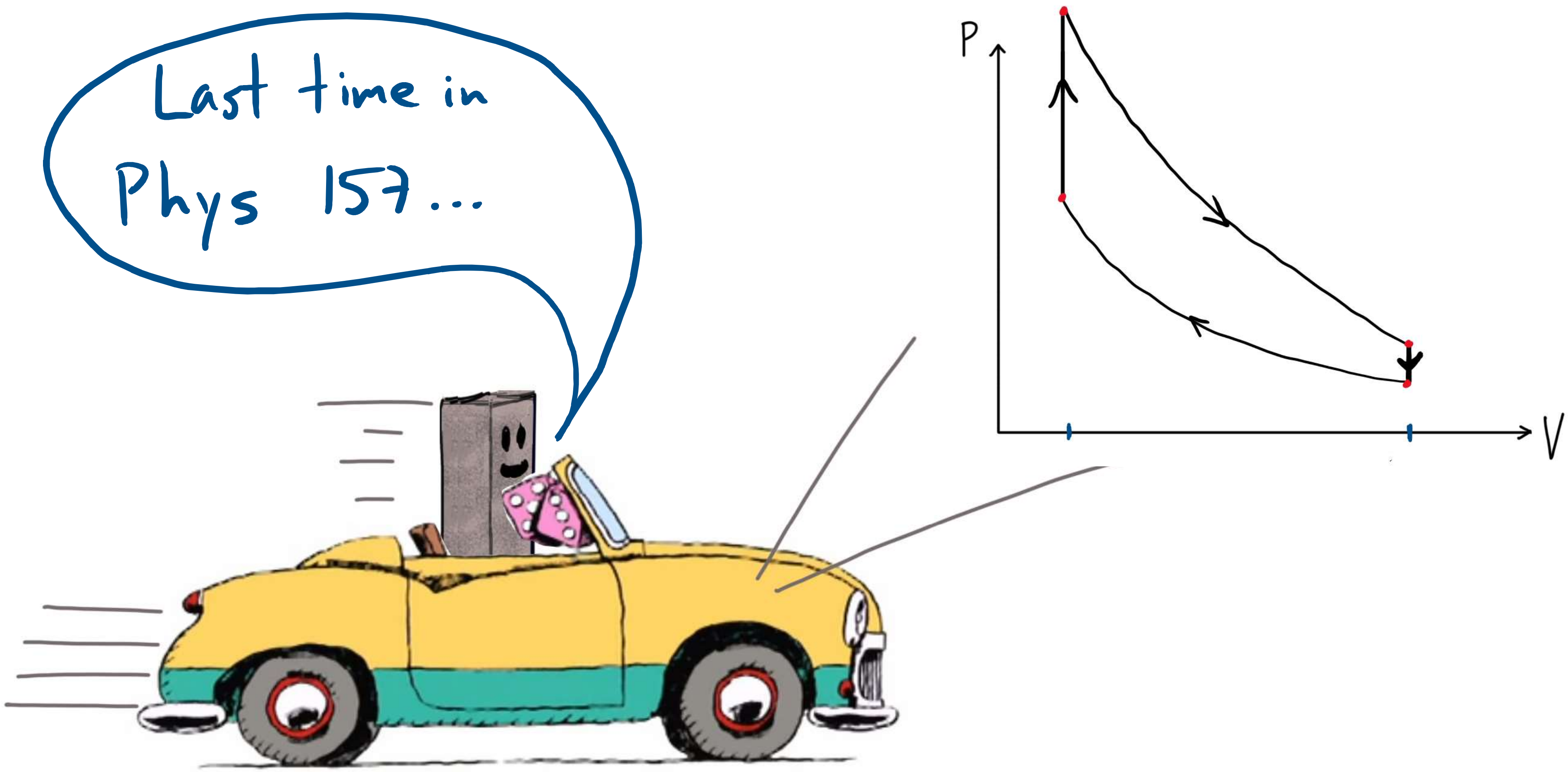
ΔU: have $\Delta U = nC_v \Delta T$ always

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

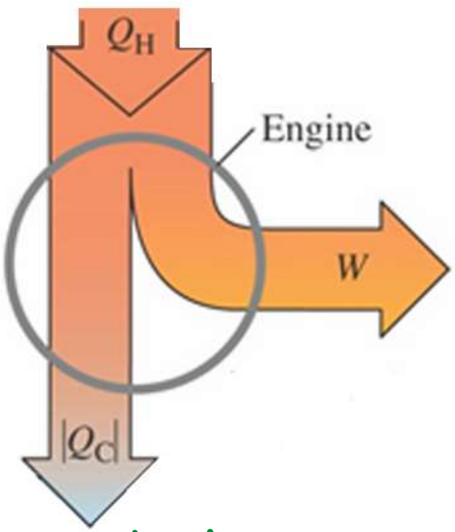
$W = nRT \ln\left(\frac{V_f}{V_i}\right)$ const T

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

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


Last time in Phys 157...
P
V

Efficiency of an Engine



$Q_H = |Q_C| + W$

Q_H : Heat absorbed by gas each cycle

$|Q_C|$: Heat expelled by gas

W : Net work done each cycle

Efficiency is: $e = \frac{W}{Q_H}$

W ← work we get out

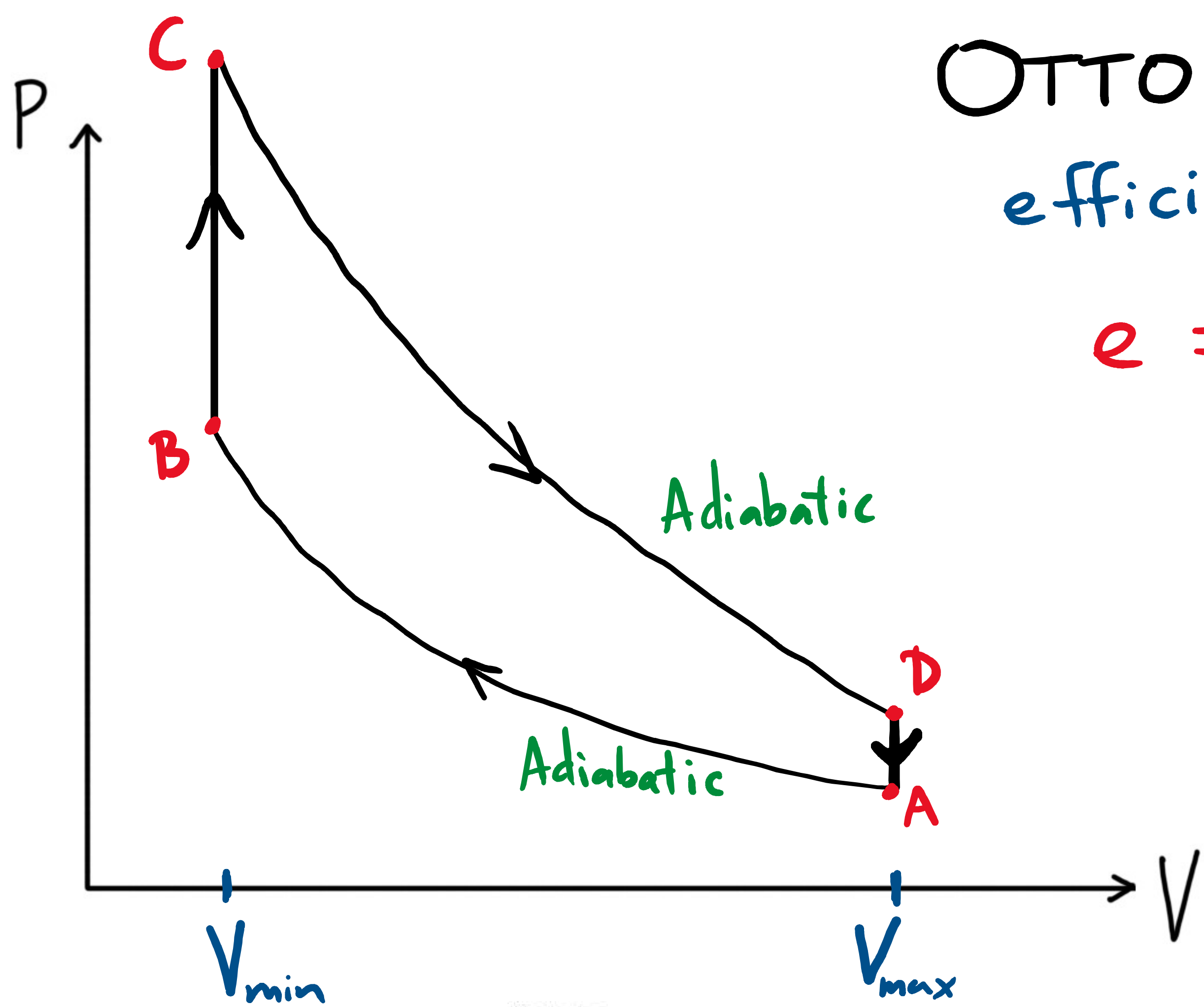
Q_H ← heat we need to supply

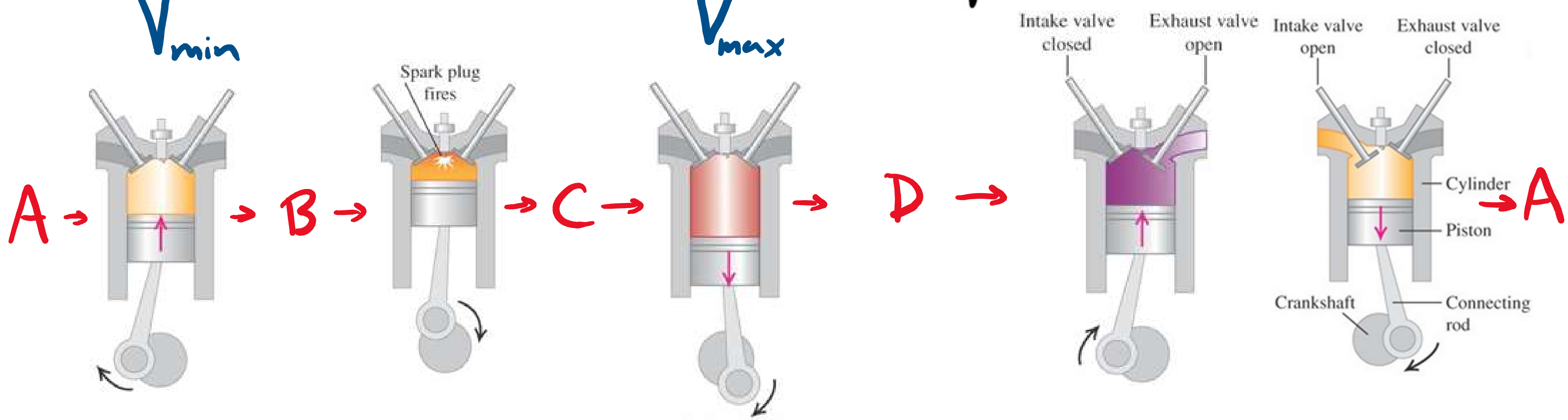
OTTO CYCLE:

efficiency

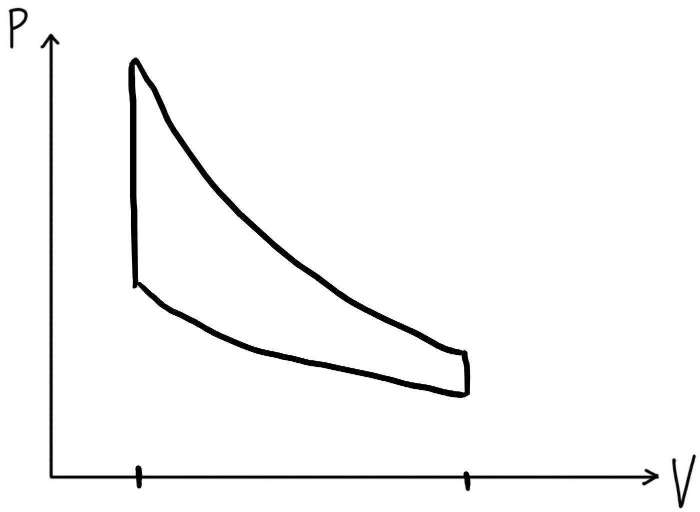
$$e = 1 - \frac{1}{r^{\gamma - 1}}$$

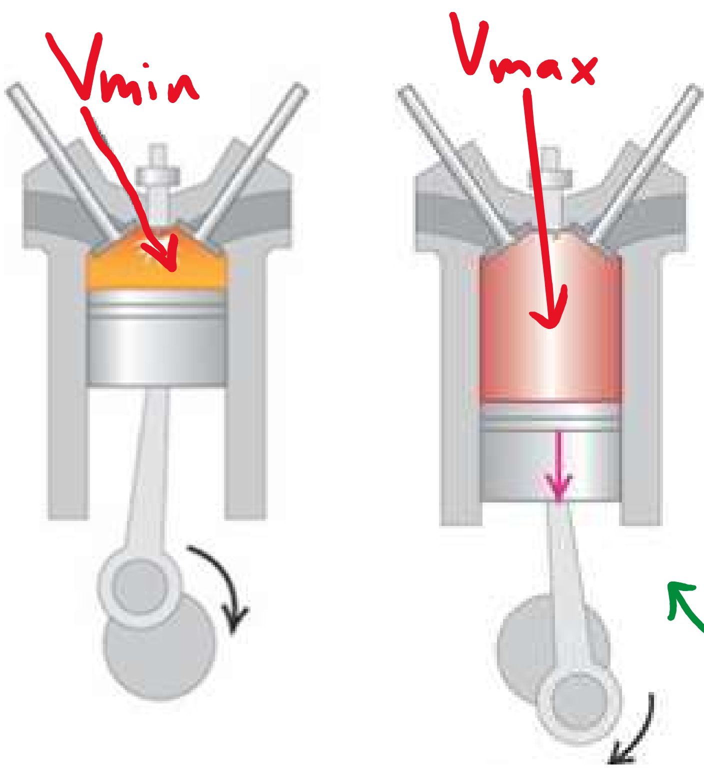
compression ratio V_{max}/V_{min}





OTTO CYCLE: efficiency is $e = 1 - \frac{1}{r^{\gamma - 1}}$





Higher efficiency for larger compression ratio.

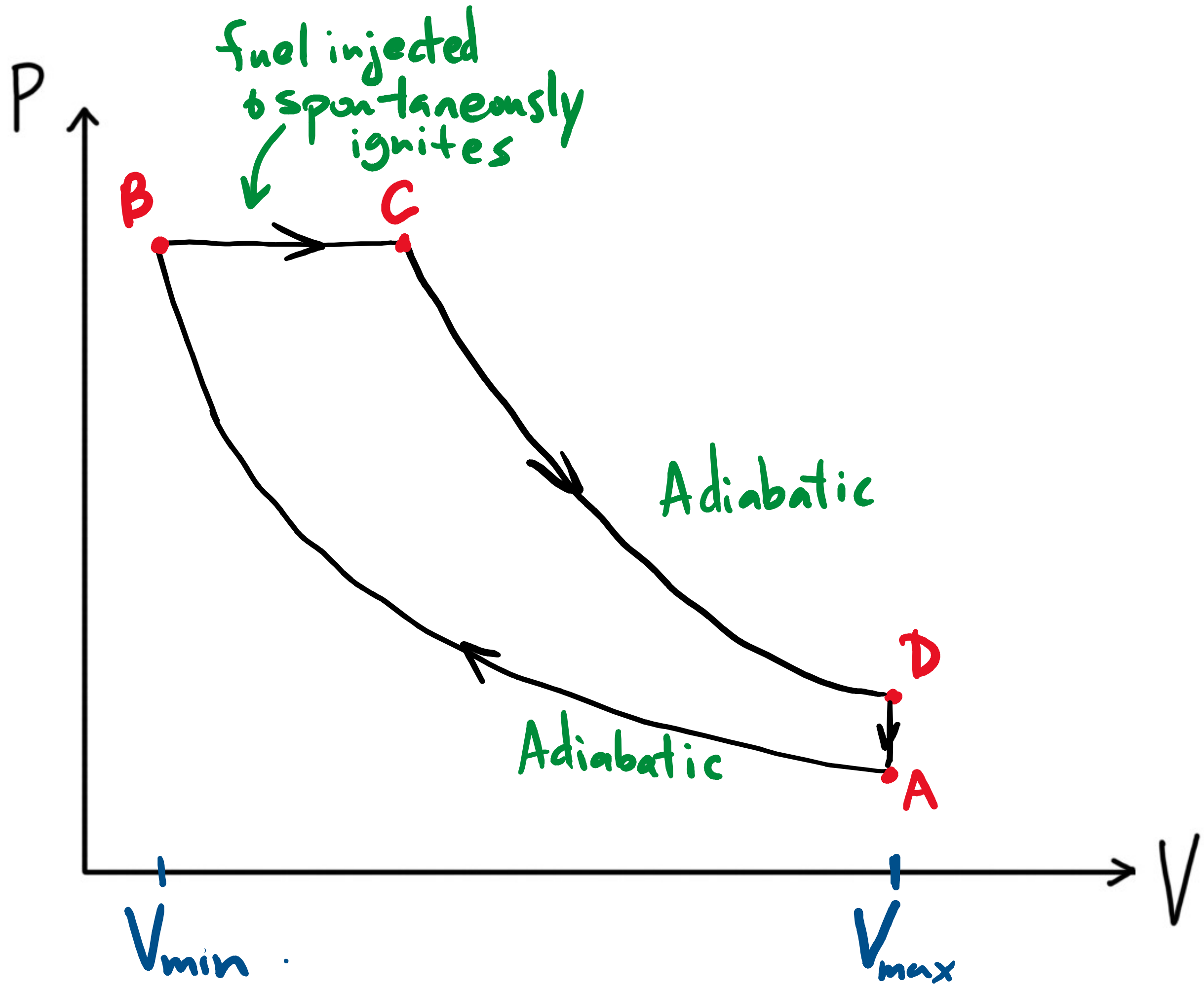
BUT: gasoline will spontaneously ignite if r too large
"engine knocking"

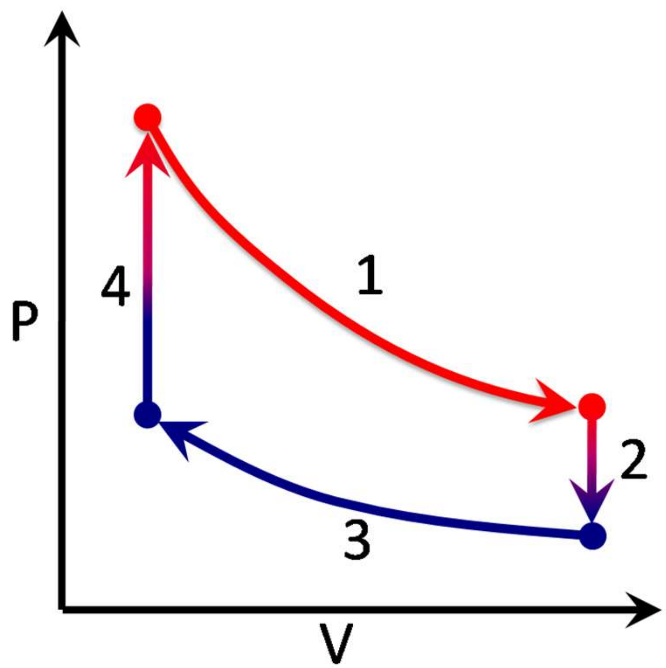
High octane fuel: higher ignition temp., so less knocking

real engines: $r = 8 - 10$

DIESEL ENGINE: larger compression ratio

- inject fuel when T very high, ignites spontaneously
- more efficient.





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

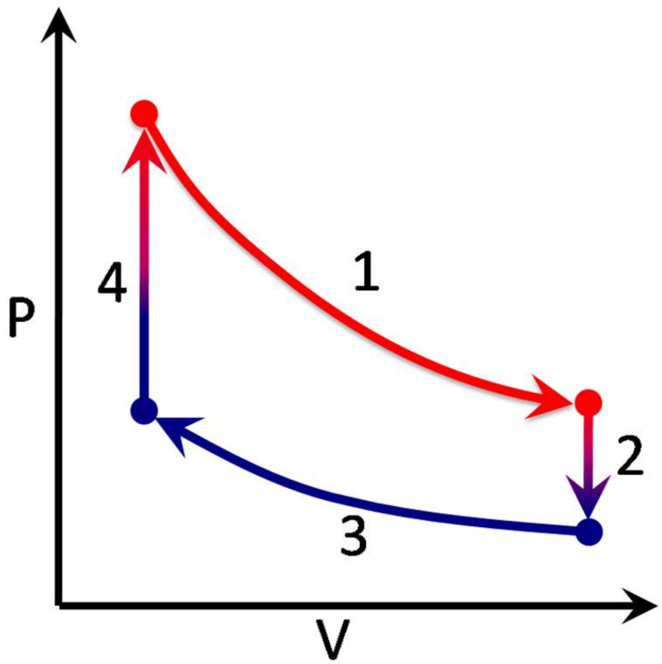
A) greater than the net work W

B) equal to the net work W

C) less than the net work W

D) always equal to zero

E) 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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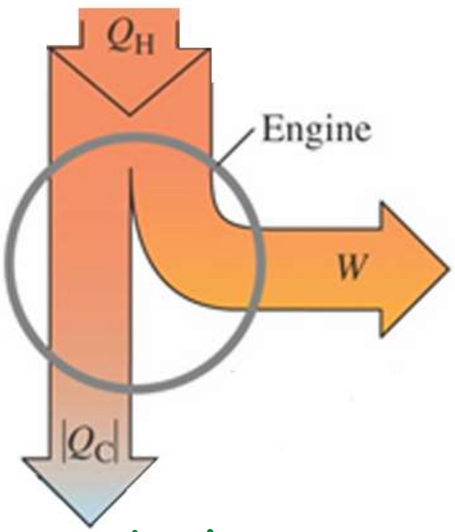
D) always equal to zero

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

$\Delta U = 0$ for full cycle

so $Q = W$

Efficiency of an Engine



$Q_H = |Q_C| + W$

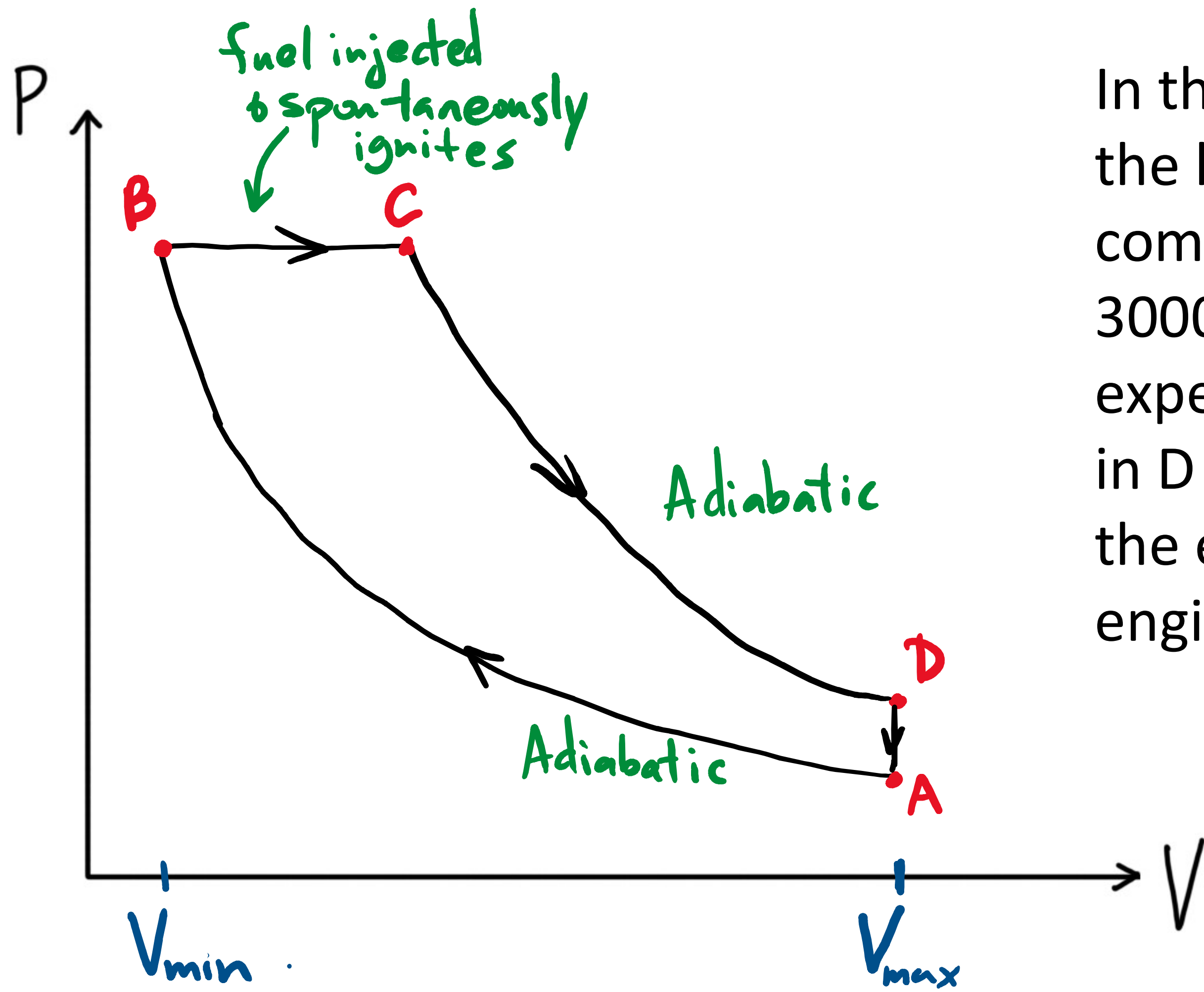
Q_H : Heat absorbed by gas each cycle

Q_C : Heat expelled by gas

W : Net work done each cycle

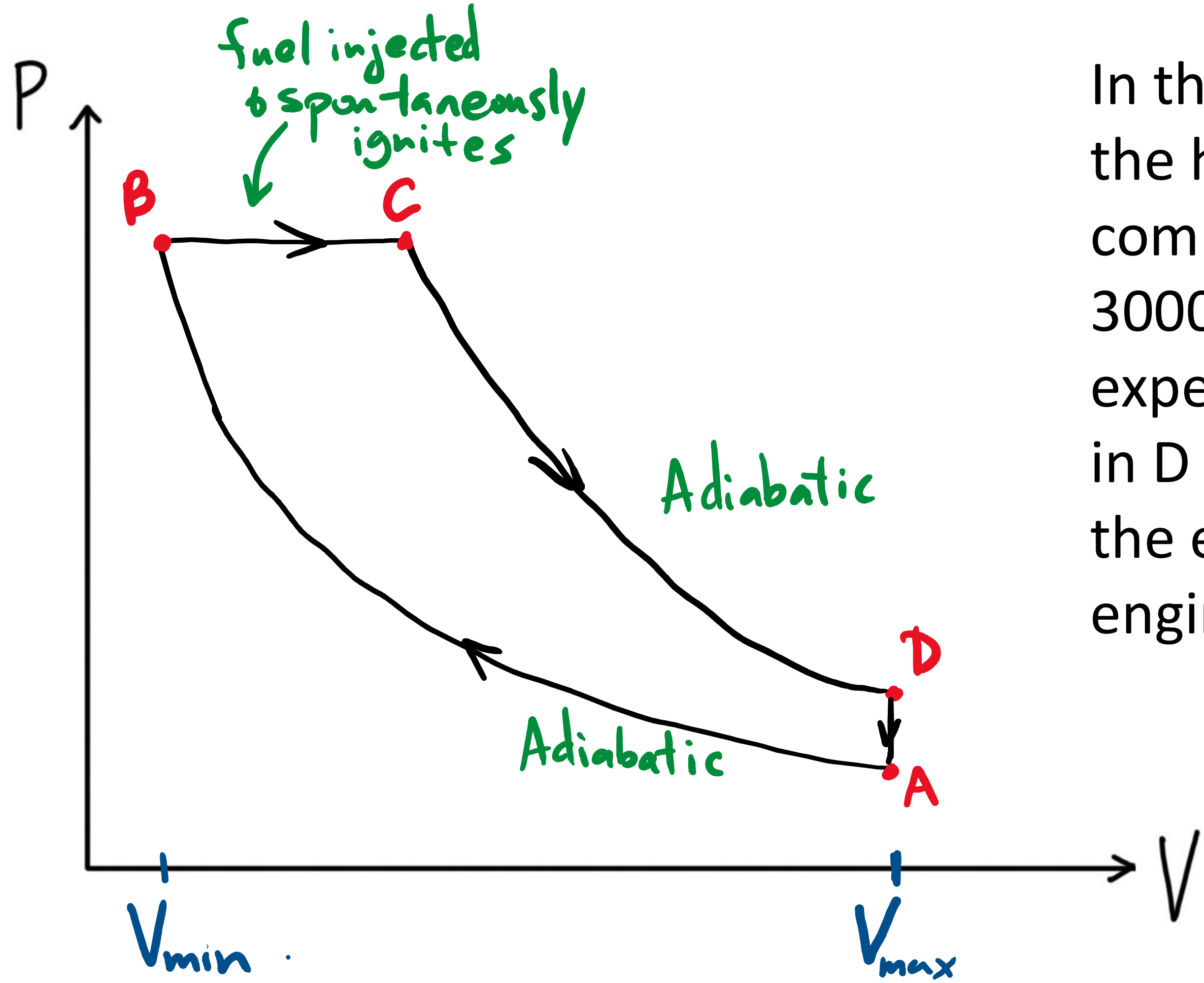
Efficiency is: $e = \dfrac{W}{Q_H}$ ← work we get out / ← heat we need to supply

$=$



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?

$W_{net} = Q_{net}$
$= 3000J - 1800J$
$= 1200J$
$Q_{in} = 3000J$
$e = \frac{1200}{3000} = 0.4$

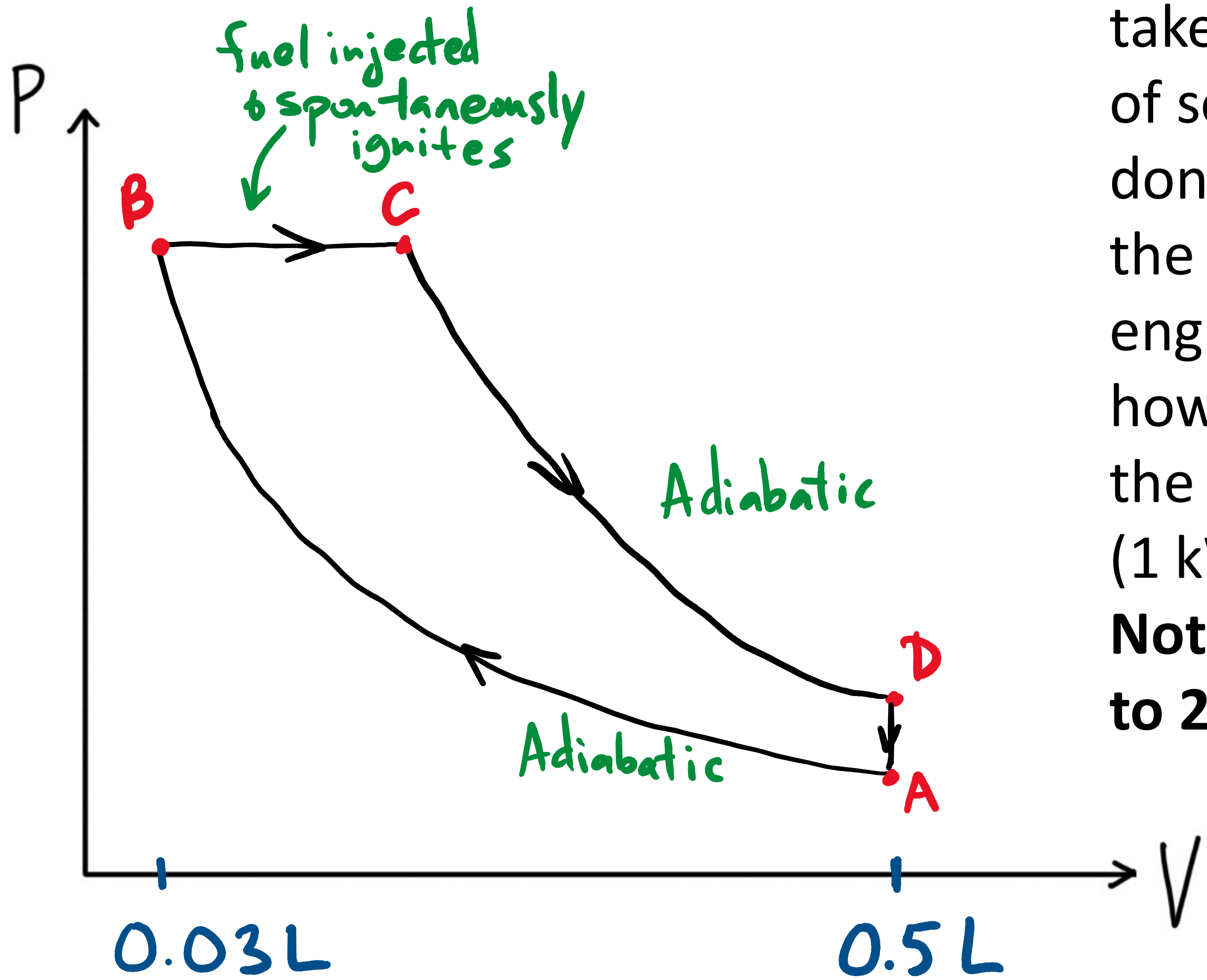
A) 0.375

B) 0.400

C) 0.600

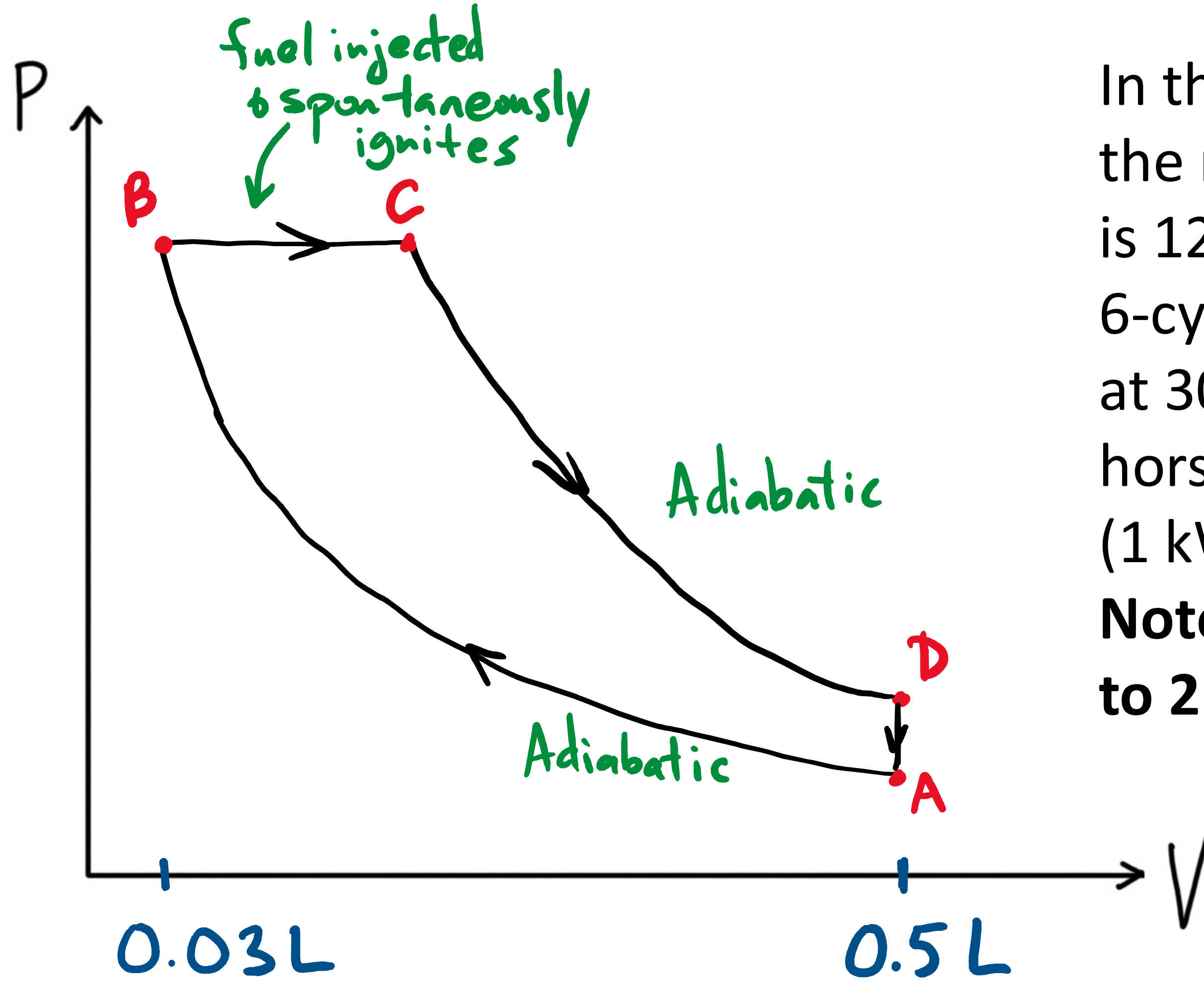
D) 0.666

E) 0.866



The Diesel cycle shown takes place in each cylinder of some car. The net work done per cycle is 1200J. If the car has a 6-cylinder engine running at 3000rpm, how many horsepower is the engine?
(1 kW = 1.33hp)
Note: 1 cycle corresponds to 2 revolutions

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



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

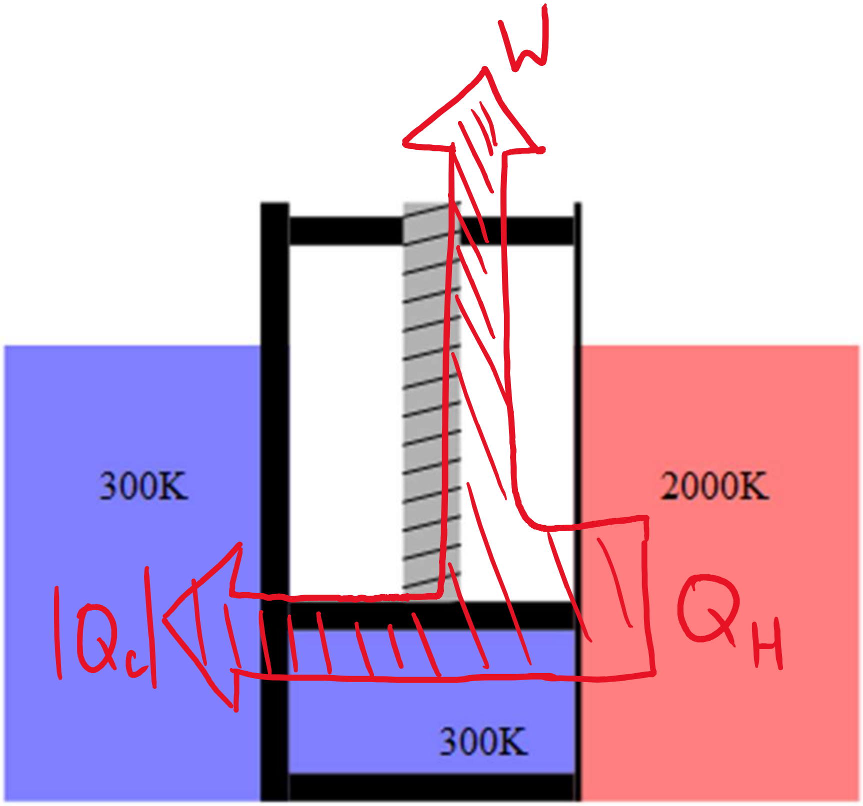
Have

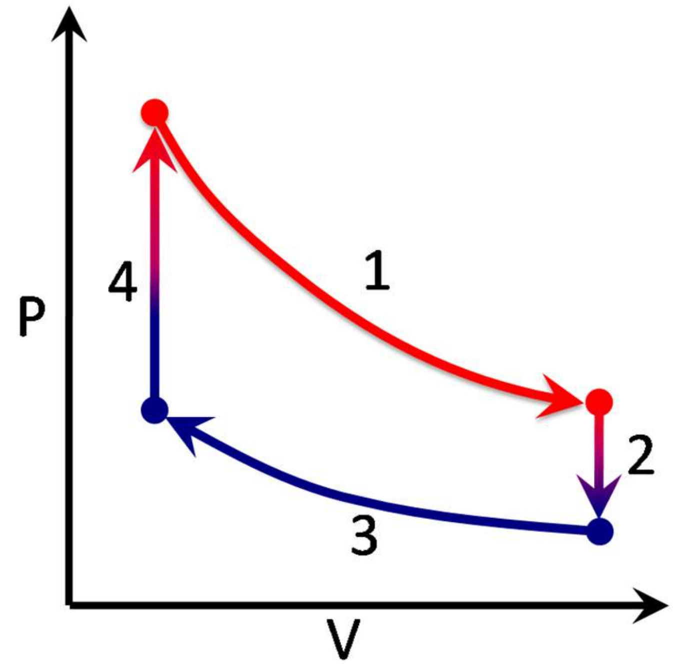
$6 \times \frac{1500}{60} = 150$ cycles per second

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

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

STIRLING CYCLE: Heat supplied by external reservoir

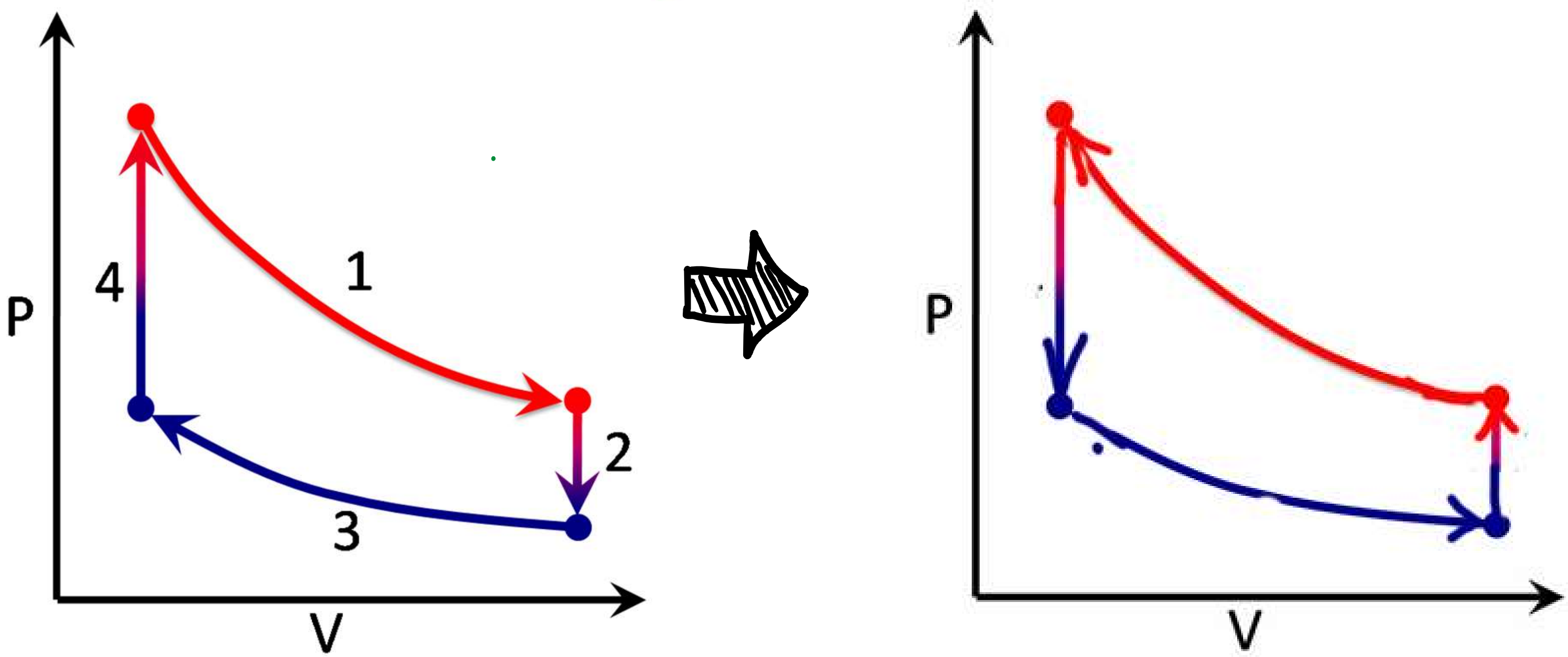


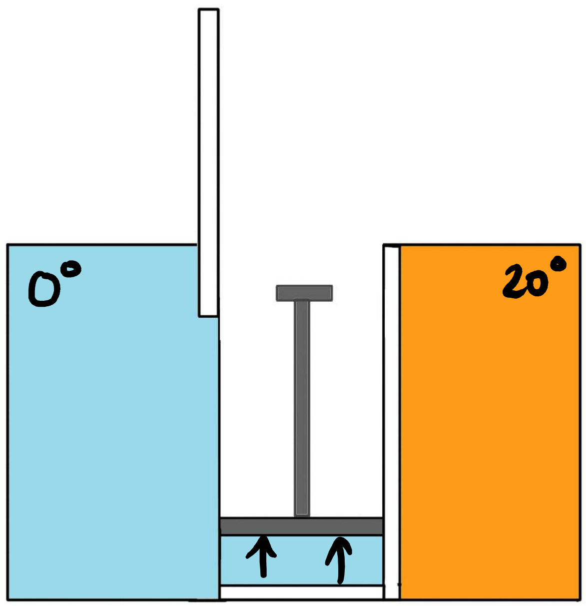


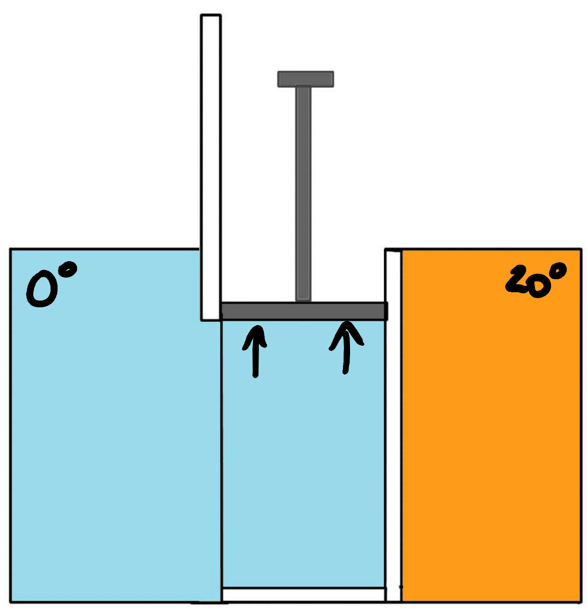
REFRIGERATORS: Can transfer heat from colder system to warmer system by doing work.

☆ Heat engine in reverse ☆

e.g.







In the process shown, 1 mole gas expands from 5L to 20L while in thermal contact with the system on the left, so that its temperature remains at 0 degrees.

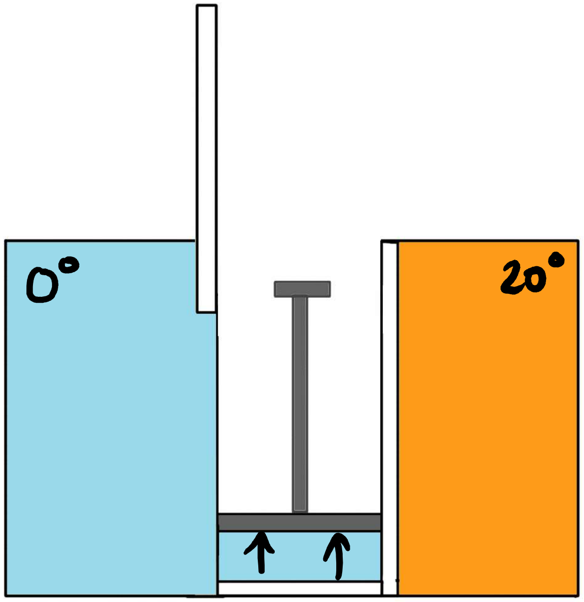
We can say that during the expansion:

A) Heat flows into the piston from the system on the left.

B) Heat flows out of the piston from the system on the left

C) There is no heat flow.

EXTRA: If heat flows, calculate how much.



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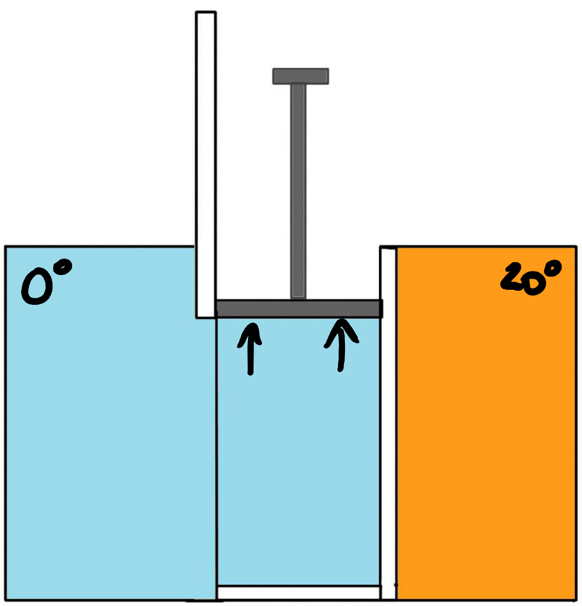


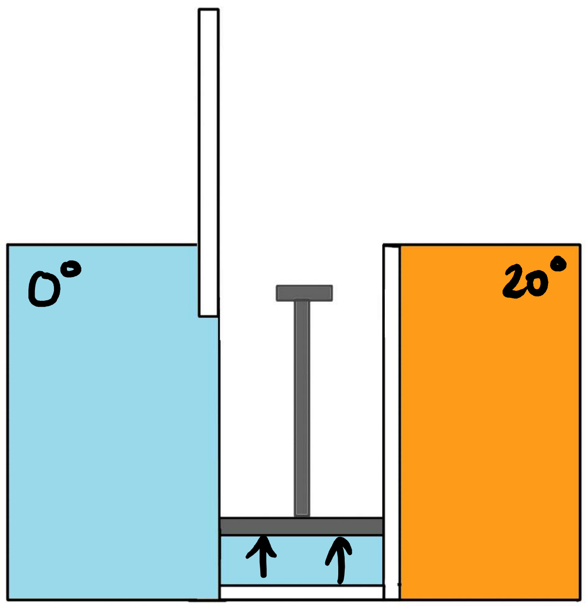
Const. T $\Rightarrow \Delta U = 0$

First Law: $\Delta U = Q - W$ so $Q = W > 0$ since gas is expanding.

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

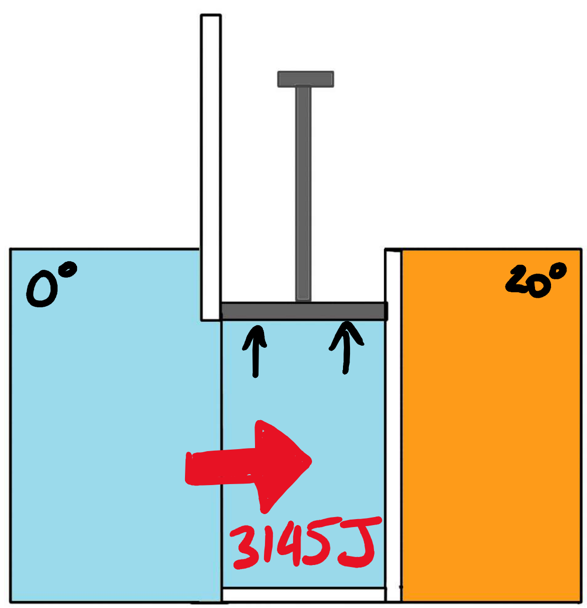
$= 1 \cdot 8.31 \cdot 273 \cdot \ln(4)$

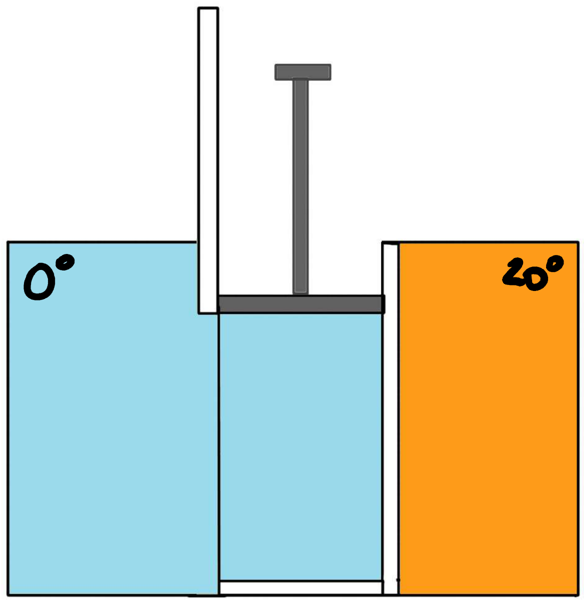
$= 3145\,J$



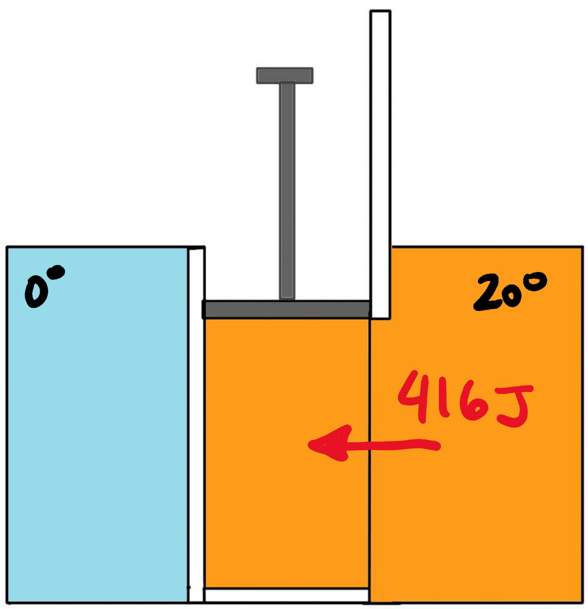
Constant temperature expansion

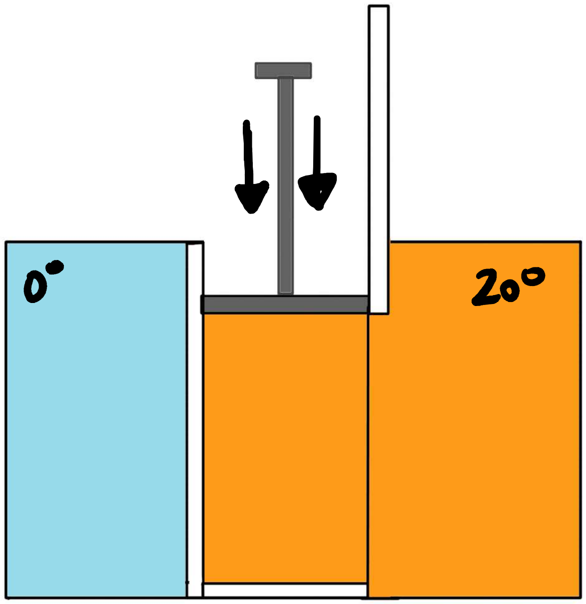
(1 mole, 5L → 20L)



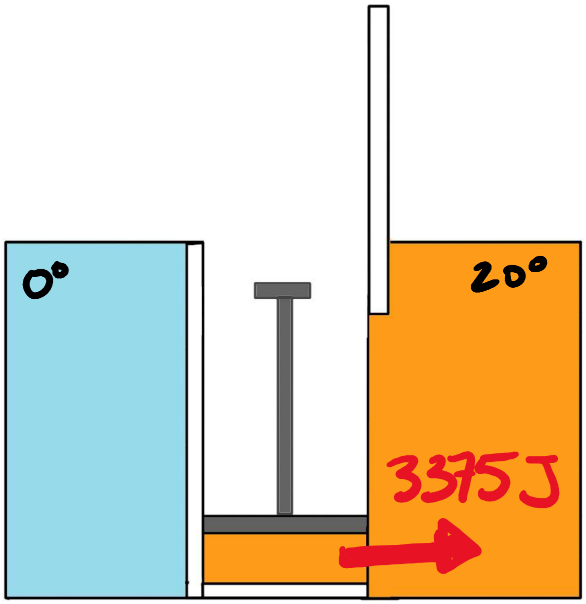


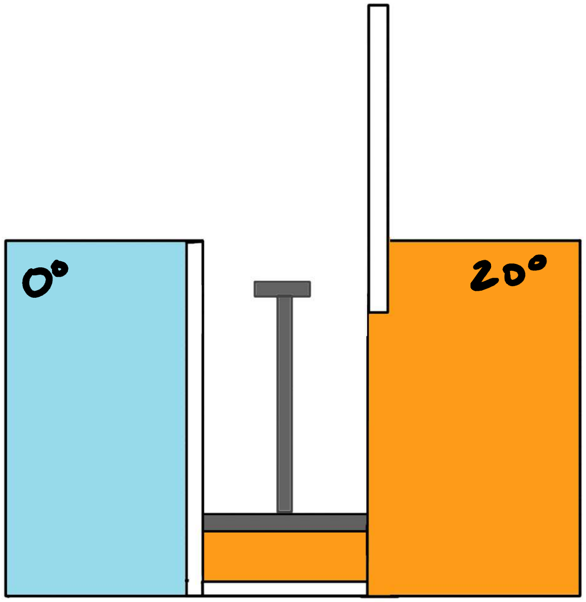
Constant volume heating



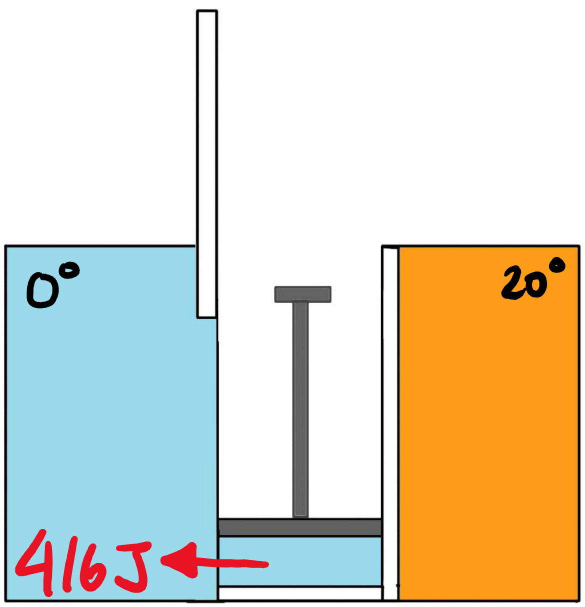


Constant temperature compression





Constant volume cooling



Net result of cycle: