Good morning!

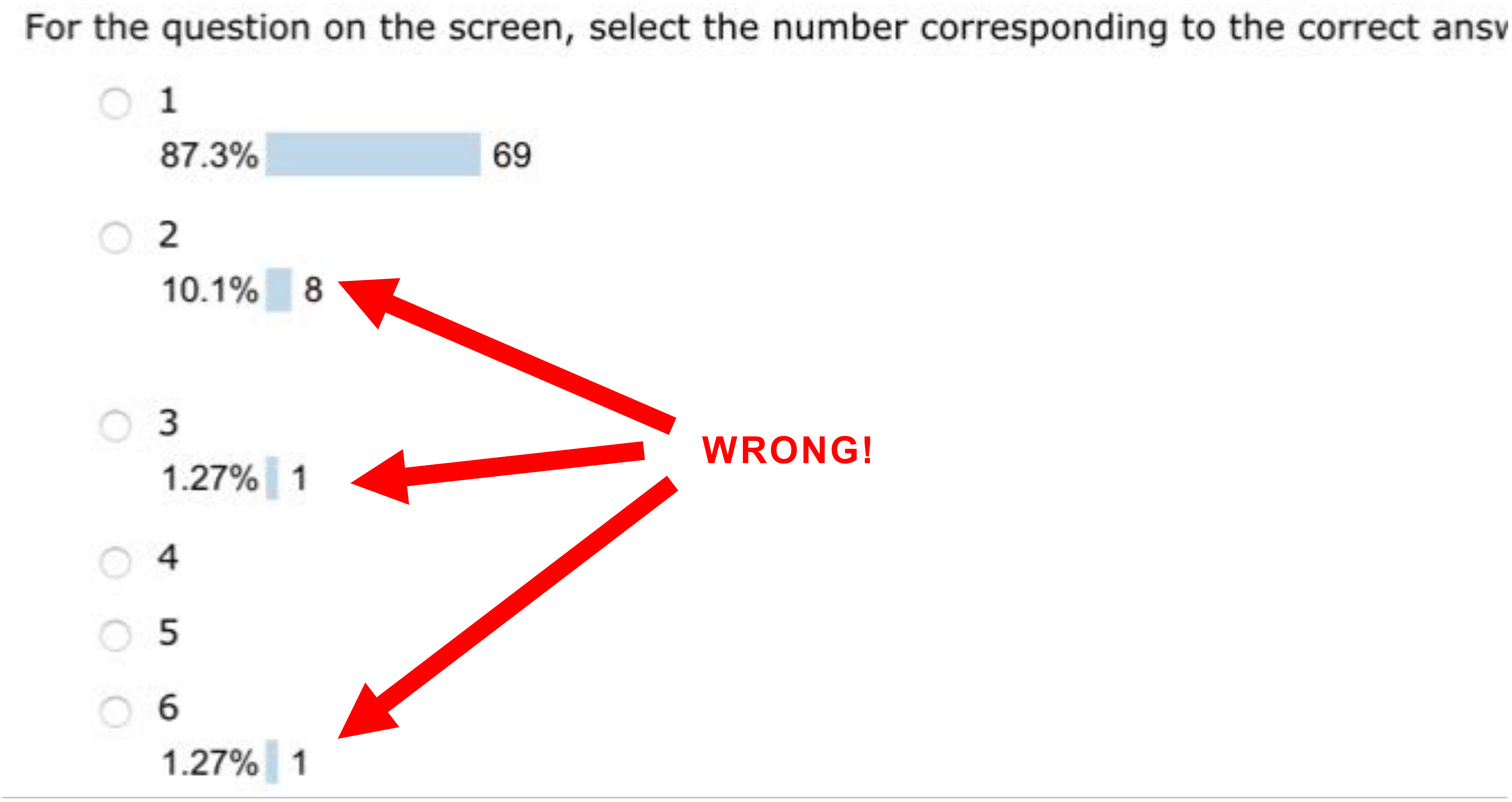
Lab 10 is in SCI136

For labs 2 – 10 the best 8 scores out of 9 will be used for the final grade calculation

Please, login into webassing, locate LectureMCQ_L24 (PY105) and answer question 1 (but ONLY Q1!).

Thank you!

For L245 Q2


For the question on the screen, select the number corresponding to the correct answ
1
87.3%
69
2
10.1%
8
3
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1
4
5
6
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1
WRONG!

The summary of the 97 % of the last topics

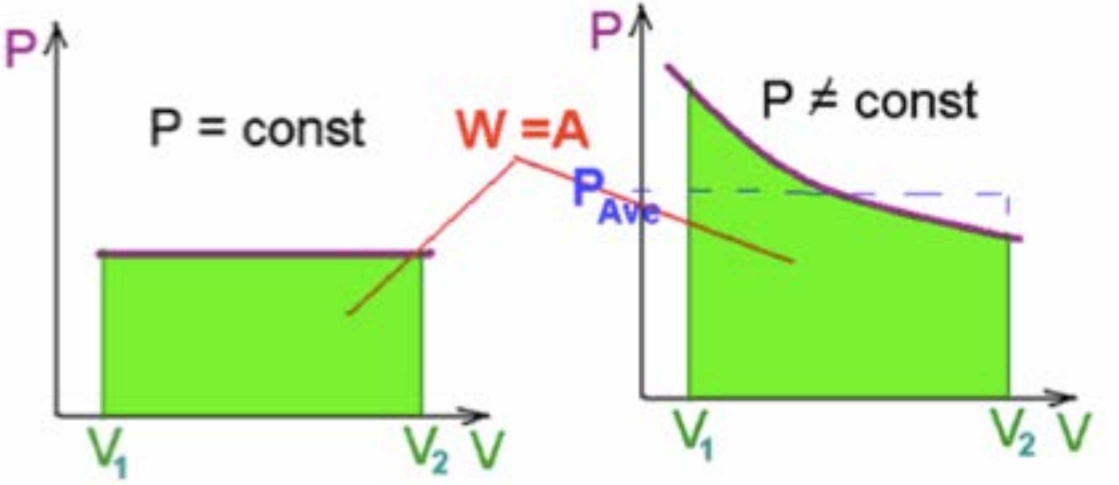
$$Q = \Delta U + W_{by\ system}$$

$$PV = nRT$$

$$U = \frac{i}{2} PV$$

$$U = \frac{i}{2} nRT$$

$$n = \frac{m}{M}$$



$W = P_{Ave} * \Delta V$ = Area (P-V graph)

$i = 3$ • for point-like particles

$i = 5$ •—• for dumbbell-like particles (no oscillations)

$i = 6$ for big particles made of 3 or more atoms (no oscillations)

Calculate the change in the internal energy of a Hydrogen gas that expands from an initial volume of 3 L and initial pressure of 300 kPa to a final volume of 7 L at *constant pressure*.

$$PV = nRT$$

$$U = \frac{i}{2}PV$$

$$U = \frac{i}{2}nRT$$

$$n = \frac{m}{M}$$

Webassign: L24 Q3

The work done by the gas during the process is …

1. < 0   2. = 0   3. > 0

Calculate the change in the internal energy of a Hydrogen gas that expands from an initial volume of 3 L and initial pressure of 300 kPa to a final volume of 7 L at *constant pressure*.

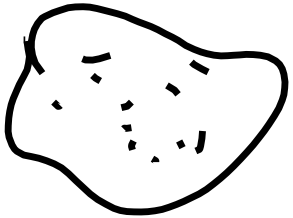
W_{by_gas} **1. < 0 2. = 0 3. > 0**

$PV = nRT$

$U = \frac{i}{2} nRT$

$U = \frac{i}{2} PV$

$n = \frac{m}{M}$



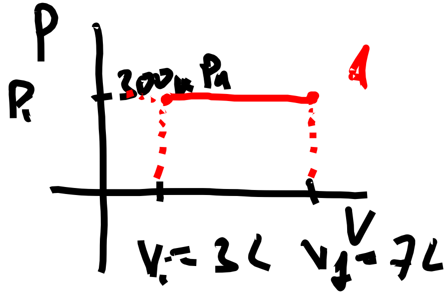
$i = ?$

$H_2 \Rightarrow i = 5$

$U_i = \frac{i}{2} P V_i$

$U_f = \frac{i}{2} P V_f$

$\Delta U = U_f - U_i = \frac{5}{2} P \cdot V_f - \frac{5}{2} P \cdot V_i = \frac{5}{2} P \cdot (V_f - V_i) = \frac{5}{2} P \Delta V = \frac{5}{2} \cdot 300\,kPa \cdot 4L = \frac{5}{2} 300 \cdot 10^3 Pa\ 4 \cdot 10^{-3} m^3 = \frac{5}{2} \cdot 300 \cdot 4 = 3000\ J$



$P = const$

$W = P \cdot \Delta V$

$V_f > V_i \Rightarrow \Delta V > 0$

Calculate the change in the internal energy of a Hydrogen gas that expands from an initial volume of 3 L and initial pressure of 300 kPa to a final volume of 7 L at *constant pressure*.

$$U = \frac{i}{2}PV$$

Webassign: L24 Q3

The work done by the gas during the process is …

1. < 0 2. $= 0$ 3. > 0

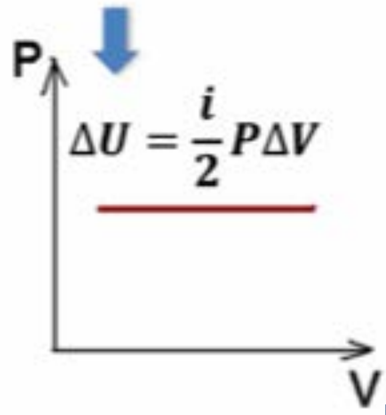
$$\Delta U = \frac{i}{2}P\Delta V$$

V and T must change!

Isobaric

P = const

V/T = const



Calculate the amount of heat a Hydrogen gas absorbs/releases when it expands from an initial volume of 3 L and initial pressure of 300 kPa to a final volume of 7 L at *constant pressure*.

$$PV = nRT$$

$$n = \frac{m}{M}$$

$$n = \frac{m}{M}$$

$$U = \frac{i}{2} nRT \quad U = \frac{i}{2} PV$$

$Q = const$; $Q = \Delta U + W = 3000 + W$

$W_{P=const} = P \Delta V = 300\,kPa \cdot 4L = 1200\ J$

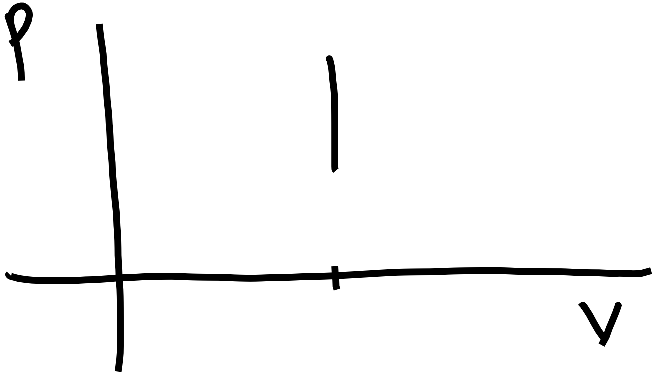
$3000 = \frac{5}{2} \cdot P \cdot \Delta V = \frac{5}{2} \cdot W \Rightarrow W = \frac{2}{5} \cdot \Delta U = \frac{2}{5} \cdot 3000$

if $P = const$ $\Delta U = \frac{i}{2} \cdot W$

$Q = 3000 + 1200 = 4200\ J > 0$

W

V = const



> 0 1.

$= 0$ 2.

< 0 3.

$$W = P_{Ave} \cdot \Delta V = P_{Ave} \cdot 0 = 0$$

A container of a monatomic ideal gas contains just the right number of moles so that $nR = 20$ J/K. The gas is in state 1 such that: $P_1 = 20$ kPa and $V_1 = 100$ L

(a) What is the temperature T_1 of the gas?

$$PV = nRT$$

$$n = \frac{m}{M}$$

$$Q = \Delta U + W_{by\ system}$$

$$U = \frac{i}{2}nRT \qquad U = \frac{i}{2}PV$$

$$W = P_{Ave} * \Delta V = \text{Area (P-V graph)}$$

A container of a monatomic ideal gas contains just the right number of moles so that $nR = 20\ J/K$. The gas is in state 1 such that: $P_1 = 20$ kPa and $V_1 = 100$ L

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$$n = \frac{m}{M}$$

$$U = \frac{i}{2} nRT$$

$$U = \frac{i}{2} PV$$

$$Q = \Delta U + W_{by\ system}$$

$$W = P_{Ave} * \Delta V = \text{Area (P-V graph)}$$

Webassign: L24 Q4

$T_1 =$

1. 100 K
2. 200 K
3. 300 K
4. …

A container of a monatomic ideal gas contains just the right number of moles so that *nR* = 20 *J/K*. The gas is in state 1 such that: P_1 = 20 kPa and V_1 = 100 L

(a) What is the temperature T_1 of the gas?

$$PV = nRT$$

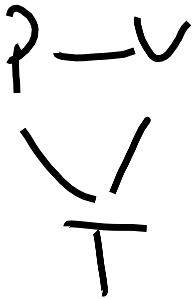
$$n = \frac{m}{M}$$

$$U = \frac{i}{2}nRT$$

$$U = \frac{i}{2}PV$$

$$Q = \Delta U + W_{by\ system}$$

$$W = P_{Ave} * \Delta V = \text{Area (P-V graph)}$$



$\Rightarrow$

$$PV = nR\,T$$

$$20\ kPa \cdot 100\ L = 20\ T_1$$

$$\frac{20 \cdot 100}{20} = T_1$$

$$T_1 = 100\ K$$

A container of monatomic ideal gas contains just the right number of moles so that nR = 20 *J/K*. The gas is in state 1 such that: P_1 = 20 kPa and V_1 = 100 L

(a) What is the temperature T_1 of the gas?

Use the ideal gas law: $PV = nRT$, so:

$T_1 = P_1V_1/nR$ = *2000/20* = 100 K

A container of a monatomic ideal gas contains just the right number of moles so that $nR = 20$ J/K. The gas is in state 1 such that: $P_1 = 20$ kPa and $V_1 = 100$ L.

(b) If Q = 2500 J of heat is added to the gas, and the gas expands at constant pressure, the gas will reach a new equilibrium state 2. What is the final temperature T_2?

A monatomic gas has just the right number of moles; $nR = 20$ *J/K*. The initial state : $P_1 = 20$ kPa and $V_1 = 100$ L. (b) If Q = 2500 J of heat is added to the gas, and the gas expands at constant pressure, what is the final temperature T_2?

Webassign: L24 Q5

1. $PV = nRT$
2. $n = \frac{m}{M}$
3. $U = \frac{i}{2} nRT$
4. $U = \frac{i}{2} PV$
5. $Q = \Delta U + W_{by\ system}$
6. $W = P_{Ave} * \Delta V =$ Area (P-V graph)

To *relate* T_2 and Q we will NOT need to use equation…

1. 2. 3. 4. 5. …

A monatomic gas has just the right number of moles; $nR = 20$ *J/K*. The initial state : $P_1 = 20$ kPa and $V_1 = 100$ L. (b) If Q = 2500 J of heat is added to the gas, and the gas expands at constant pressure, what is the final temperature T_2?

Webassign: L24 Q5

1. $PV = nRT$
2. $n = \frac{m}{M}$
3. $U = \frac{i}{2}nRT$
4. $U = \frac{i}{2}PV$
5. $Q = \Delta U + W_{by\ system}$
6. $W = P_{Ave} * \Delta V = \text{Area (P-V graph)}$

To *relate* T_2 and Q we will NOT need to use equation…

1. 2. 3. 4. 5. …

Q – T

$Q = c \cdot m \Delta T$

Q — ΔU — T; W — P, V

$2500 = Q = \Delta U + W = \frac{3}{2} nR \cdot \Delta T + P \cdot \Delta V =$

$= \frac{3}{2} nR \cdot \Delta T + nR \Delta T = \Delta T \cdot 20 \cdot \left(\frac{3}{2} + 1\right)$

$\Delta T = \frac{2500}{20 \cdot \frac{5}{2}} = 50$ K

$T_2 = T_1 + \Delta T \Rightarrow T_2 = 150$ K

A container of monatomic ideal gas contains just the right number of moles so that $nR = 20\ J/K$. The gas is in state 1 such that: $P_1 = 20$ kPa and $V_1 = 100$ L.
(b) If Q = 2500 J of heat is added to the gas, and the gas expands at constant pressure, the gas will reach a new equilibrium state 2. What is the final temperature T_2? We've already seen that, at constant pressure for a monatomic ideal gas: $PV = nRT$ P = const => $W = P\Delta V = nR\Delta T$

$$Q = \Delta U + W = (3/2)nR\Delta T + nR\Delta T = (5/2)nR\Delta T$$

Therefore $\Delta T = (2/5)Q/nR = 1000/20 = 50$ K.

$$T_2 = T_1 + \Delta T = 150 \text{ K}$$

(c) How much work was done by the gas during the expansion?

$$W = P \cdot \Delta V = nR \cdot \Delta T = 20 \cdot 50 = 1000\ J$$

$$\Delta U = Q - W = 2500 - 1000 = 1500\ J$$

(d) What is the final volume V_2?

$$P_2 V_2 = nR \cdot T_2 \Rightarrow V_2 = \frac{20 \cdot 150}{20 \times P_a} = 150\ L$$

(c) How much work was done by the gas during the expansion?

$W = P\Delta V = nR\Delta T = 20 * 50 = 1000$ J

(This equation is true ***only*** for a ***constant pressure*** process)

(d)What is the final volume V_2?

One approach is to bring in the ideal gas law again:

$V_2 = nRT_2/P_2 = 20(150)/(20\mathrm{x}10^3) = 150\mathrm{x}10^{-3}\ \mathrm{m}^3$

62,325 J of heat energy is transferred to a system consisting of 30 moles of an ideal gas. If the volume of this gas stays constant at 40 L, calculate the change in the internal energy of the gas.

Webassign: L24 Q7

The work of the gas is

1. > 0
2. = 0
3. < 0

Webassign: L24 Q6

ΔU is

1. > 62,325 J
2. = 62,325 J
3. < 62,325 J

62,325 J of heat energy is transferred **to** a system consisting of 30 moles of an ideal gas. If the volume of this gas stays constant at 40 L, calculate the change in the internal energy of the gas.

Webassign: L24 Q7

The work of the gas is

1. > 0
2. = 0
3. < 0

$V = const$

$W = 0$

Webassign: L24 Q6

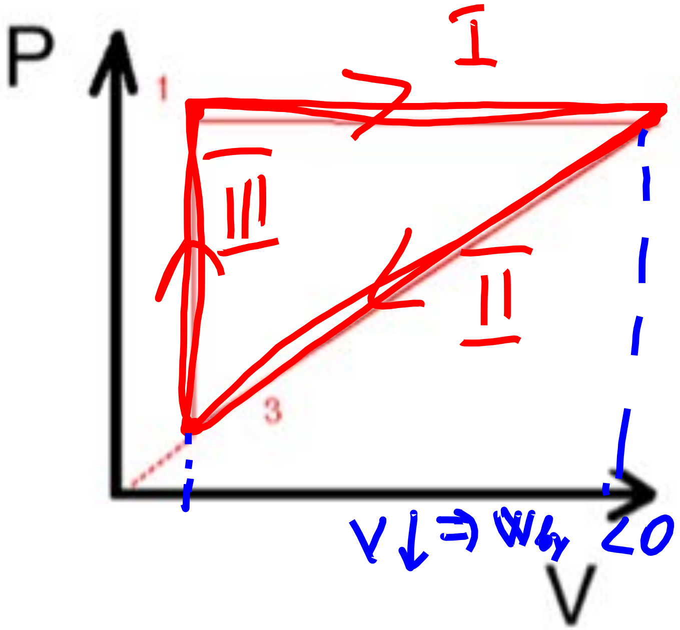
ΔU is

1. > 62,325 J
2. = 62,325 J
3. < 62,325 J

$Q = \Delta U + W$

$Q > 0\ ;\ W = 0 \Rightarrow \Delta U = Q > 0$

$\Delta U = Q = 62325\ J$



Webassign: L24 Q8

A diatomic gas is a subject of three different processes. The work done on the gas during process 2 -> 3 is …

1. < 0 2. = 0 3. > 0

$nR = 300$ J/K

$P_1 = 600$ kPa

$P_3 = 200$ kPa

$V_1 = 40$ L

$V_2 = 120$ L

$W_{by} = -W_{on}$

$$PV = nRT$$

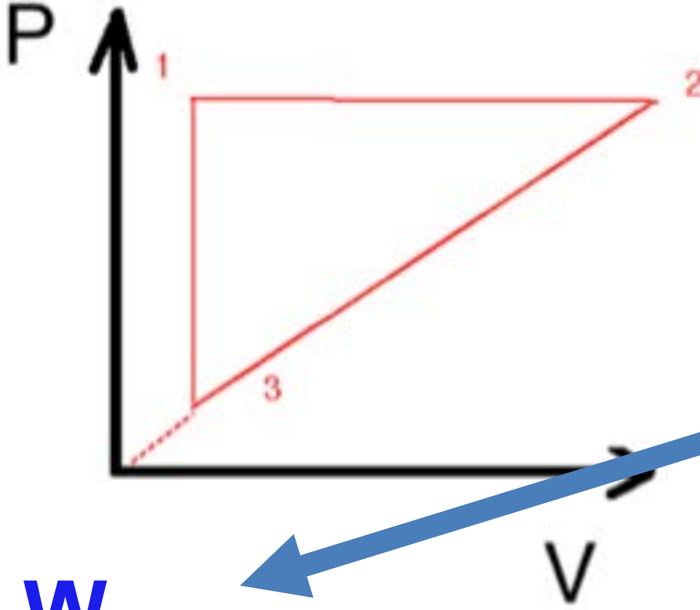
$$Q = \Delta U + W_{by\ system}$$

$$U = \frac{i}{2} nRT$$

$$U = \frac{i}{2} PV$$

$$n = \frac{m}{M}$$

$$W = P_{Ave} * \Delta V = \text{Area (P-V graph)}$$



Webassign: L24 Q8

A diatomic gas is a subject of three different processes. The work done on the gas during process 2 -> 3 is …

1. < 0 2. = 0 3. > 0

W_{on_gas} …

>0

$$PV = nRT$$

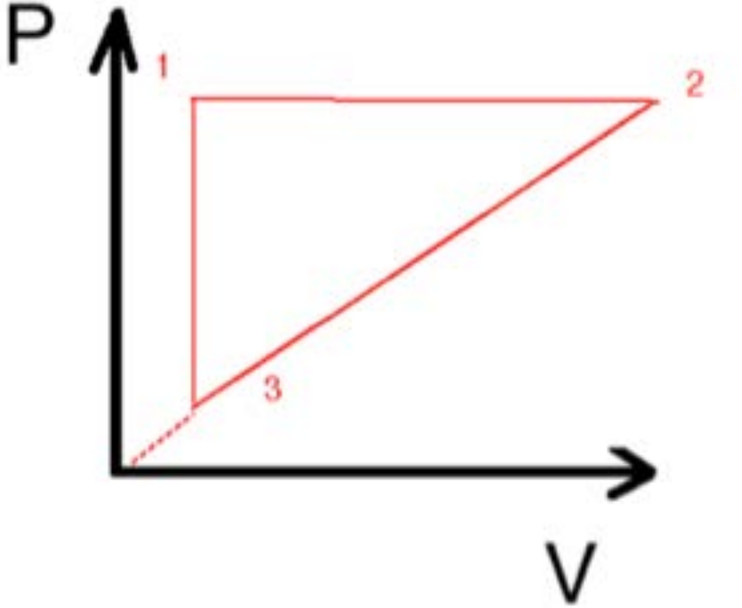
$$Q = \Delta U + W_{by\ system}$$

$$U = \frac{i}{2} nRT$$

$$U = \frac{i}{2} PV$$

$$n = \frac{m}{M}$$

$$W = P_{Ave} * \Delta V = \text{Area (P-V graph)}$$



A diatomic gas is a subject of three different processes. Calculate the work done by the gas during process 1->2

$$PV = nRT$$

$$Q = \Delta U + W_{by\ system}$$

nR = 300 J/K

P_1 = 600 kPa

P_3 = 200 kPa

V_1 = 40 L

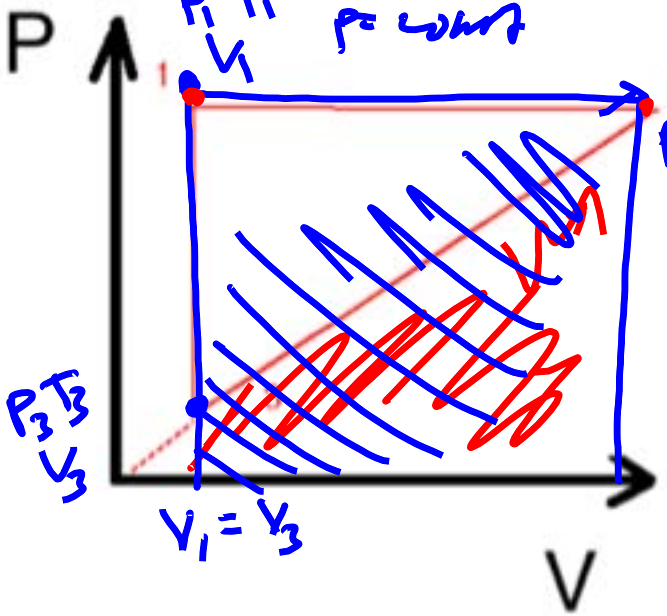
V_2 = 120 L

$$U = \frac{i}{2}nRT$$

$$U = \frac{i}{2}PV$$

$$n = \frac{m}{M}$$

$$W = P_{Ave} * \Delta V = \text{Area (P-V graph)}$$



A diatomic gas is a subject of three different processes. Calculate the work done by the gas during process 1->2

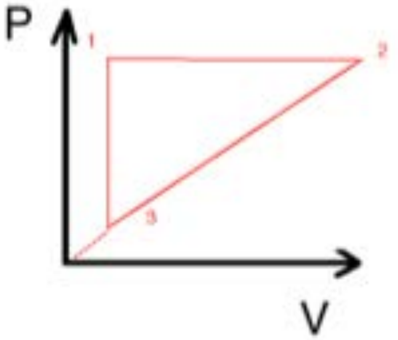
$nR = 300$ J/K

$P_1 = 600$ kPa

$P_3 = 200$ kPa

$V_1 = 40$ L

$V_2 = 120$ L



A diatomic gas is a subject of three different processes.

Calculate … everything!

$nR = 300$ J/K
$P_1 = 600$ kPa
$P_3 = 200$ kPa
$V_1 = 40$ L
$V_2 = 120$ L

↳ P, T, V → State

Q, ΔU, W → Pro.....

$PV = nRT$

$$n = \frac{m}{M}$$

$$U = \frac{i}{2} nRT$$

$$U = \frac{i}{2} PV$$

$$Q = \Delta U + W_{by\ system}$$

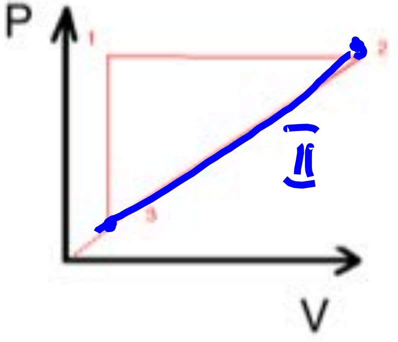
$$W = P_{Ave} * \Delta V = \text{Area (P-V graph)}$$

$$T_1 = \frac{P_1 V_1}{n \cdot R} = \frac{600 \cdot 40}{300} = 80\ K$$

$$T_2 = \frac{P_2 V_2}{nR} = \frac{P_1 V_2}{Rn} = \frac{600 \cdot 120}{300} = 240\ K$$

$$\Delta U_{1\to2} = \frac{i}{2} nR\Delta T = \frac{i}{2} P\Delta V = \frac{i}{2} \cdot W =$$

$$= \frac{5}{2} \cdot 48000\ J$$



A diatomic gas is a subject of three different processes. Calculate … everything!

$nR = 300$ J/K
$P_1 = 600$ kPa
$P_3 = 200$ kPa
$V_1 = 40$ L
$V_2 = 120$ L

$$PV = nRT$$

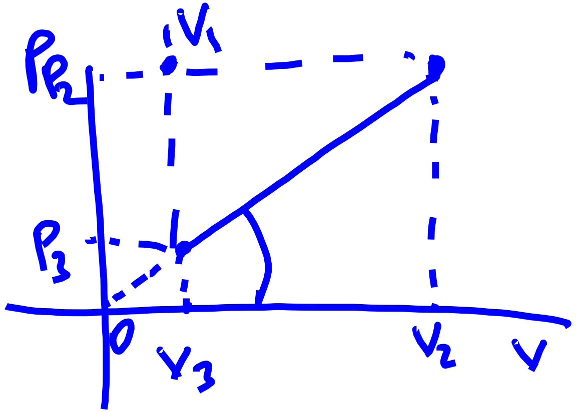
$$n = \frac{m}{M}$$

$$U = \frac{i}{2}nRT$$

$$U = \frac{i}{2}PV$$

$$Q = \Delta U + W_{by\ system}$$

W = P_{Ave} * ΔV = Area (P-V graph)



$P_2 =$

$$\frac{P_2}{V_2} = \frac{P_3}{V_3}$$

$$\frac{600}{120} = \frac{200}{40} = 5$$

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