Piston Pathways

Read a PV path to determine gas work

HS-PSII-2.6 "Using PV graphs, qualitatively and quantitatively determine how changes in the pressure, volume, or temperature of an ideal gas allow the gas to do work and classify the work as either done on or done by the gas."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline statements that tell you when work happens and who does it. Circle the calculation rule you can use for a horizontal PV path.

A Gas Behind a Piston

1. A sealed cylinder of ideal gas pushes a movable piston. On a pressure-volume (PV) graph, volume runs along the horizontal axis and pressure runs along the vertical axis. Each point describes one state of the gas. The table tracks the same trapped gas through four stages. Imagine connecting consecutive stages with straight lines on a PV grid.

SUCCESSIVE STATES OF THE GAS

Stage	Pressure (kPa)	Volume (L)	Temperature (K)
A	100	2	300
B	100	4	600
C	150	4	900
D	150	2	450

2. A gas does mechanical work only when its boundary moves and volume changes. On a PV graph, the area under a path gives the work's magnitude. For a horizontal path, multiply pressure in kilopascals by the volume change in liters. One kilopascal-liter equals one joule. Expansion means work done by the gas; compression means work done on it.

3. Heating does not automatically mean the gas does work. At a fixed volume, the piston cannot move, even if temperature and pressure rise. For a fixed amount of ideal gas, pressure times volume divided by temperature, in kelvins, stays constant. Read the table as a journey: rising temperature alone cannot tell you whether the gas does work.

2 ANSWER WITH EVIDENCE

Use the passage

1. From A to B, which way does the path move on a PV graph? Calculate the work and state who does it.

2. From B to C, how does the path move on a PV graph? How much work occurs, despite the temperature change?

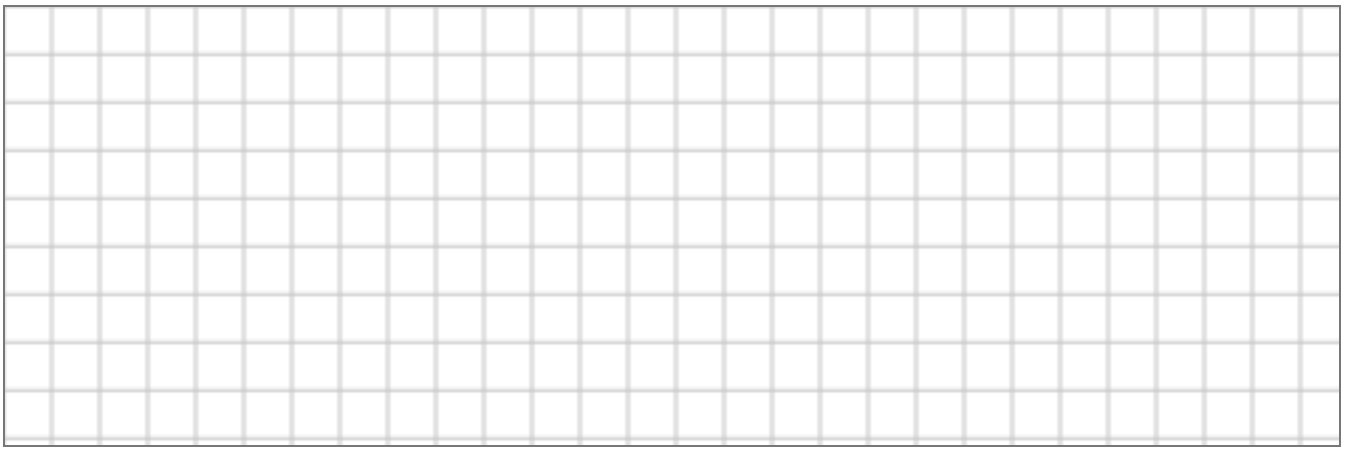
3. From C to D, calculate the work's magnitude and classify it as done on or done by the gas.

4. Across the full path from A through D, what is the net work, and on which side is it done? Does the gas's temperature rise or fall overall?

3 YOUR TURN

Your own words

On the grid, start at 2 L, 80 kPa, and 240 K. Draw and label a two-segment PV path with a horizontal expansion to a volume you choose, followed by a vertical change to a pressure you choose. Give the temperature at each new state, then calculate and classify the work for each segment.



ANSWER KEY

Piston Pathways

HIGH SCHOOL · HS-PSII-2.6

PART 1 · READ AND MARK

Underline statements that tell you when work happens and who does it. Circle the calculation rule you can use for a horizontal PV path. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	From A to B, which way does the path move on a PV graph? Calculate the work and state who does it.	**The path moves right at constant pressure. The gas does 100 kPa × 2 L = 200 J of work.**
2	From B to C, how does the path move on a PV graph? How much work occurs, despite the temperature change?	**The path moves straight up at 4 L. Temperature rises from 600 K to 900 K, but the work is 0 J because volume does not change.**
3	From C to D, calculate the work's magnitude and classify it as done on or done by the gas.	**The magnitude is 150 kPa × 2 L = 300 J. The volume decreases, so the work is done on the gas.**
4	Across the full path from A through D, what is the net work, and on which side is it done? Does the gas's temperature rise or fall overall?	**The gas does 200 J, has 300 J done on it, and has no work at constant volume. Net work is 100 J done on the gas. Temperature rises from 300 K to 450 K.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Plot (2 L, 80 kPa) to (4 L, 80 kPa), then to (4 L, 120 kPa). Label the new temperatures 480 K and 720 K, respectively. The horizontal expansion produces 80 kPa × 2 L = 160 J of work done by the gas. The vertical change produces 0 J of work.

For the open task, accept any horizontal expansion followed by a vertical pressure change with correctly calculated temperatures. Work on the vertical segment must be zero.