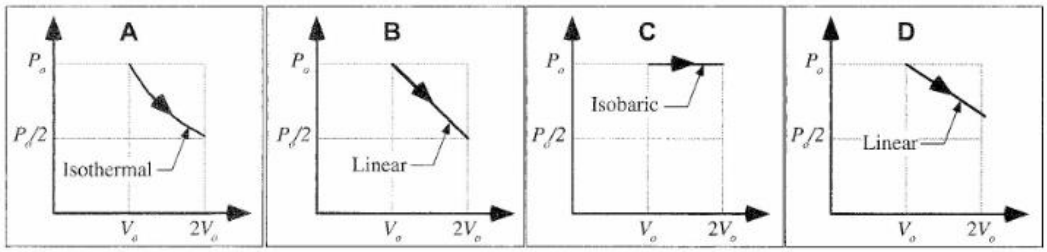
AP Physics 2 – Laws of Thermodynamics

C3-RT34: Thermodynamic Ideal Gas Processes—Final Temperature

Four thermodynamic processes are illustrated below. These processes are for the same ideal gas starting in the same state (same pressure, volume, temperature, and amount of gas) and ending at the same final volume that is twice the initial volume.



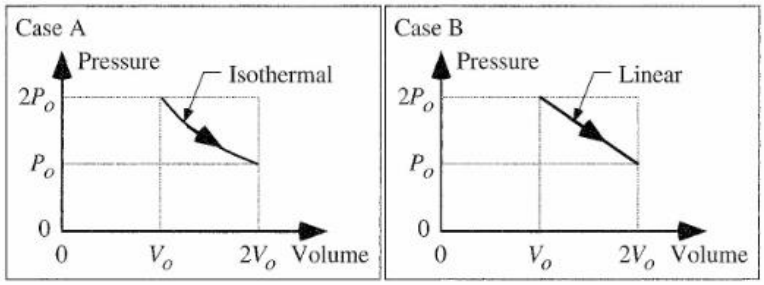
Rank the final temperature of the gas in these processes.

				OR			
1 Greatest	2	3	4 Least		All the same	All zero	Cannot determine

Explain your reasoning.

C3-CT36: Pressure–Volume Graphs for Expanding Gas—Work Done

Two containers of the same number of moles of an ideal gas are taken from the same initial state (same pressure, volume, and temperature) to the same final state by two different paths, as shown.

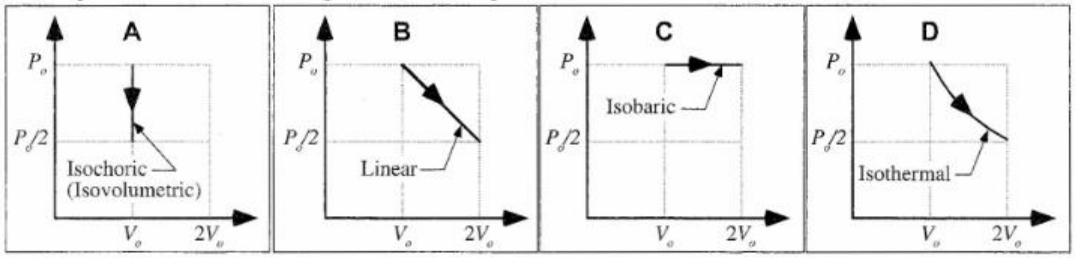


Is the work done by the gas on its surroundings (i) *greater* in Case A, (ii) *greater* in Case B, or (iii) *the same* in both cases? _____

Explain your reasoning.

C3-RT38: Pressure–Volume Graphs for Various Processes—Work Done by Gas

In each case, the same ideal gas undergoes a thermodynamic process starting in the same state (same pressure, volume, temperature, and amount of gas). The final equilibrium states are different for each case.



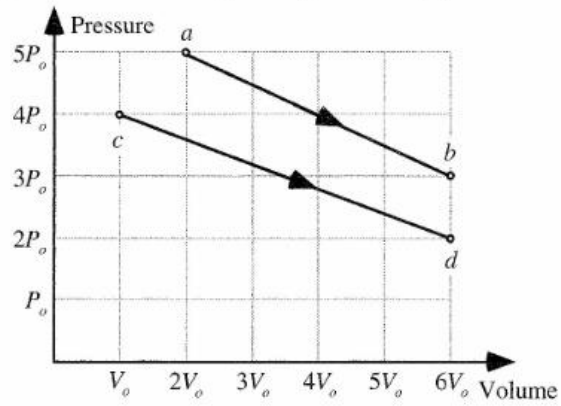
Rank the amount of work that is done by the gas on the environment for the process shown in each case.

				OR			
1 Greatest	2	3	4 Least		All the same	All zero	Cannot determine

Explain your reasoning.

C3-CT40: Pressure–Volume Graph for Processes—Work Done

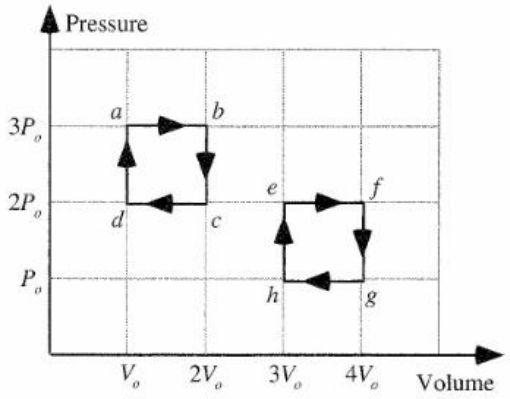
Two processes $a \Rightarrow b$ and $c \Rightarrow d$ are shown on the pressure versus volume graph. A sample of an ideal gas is expanded using process $a \Rightarrow b$, and an identical sample is expanded using process $c \Rightarrow d$.



Is the work done by the gas in process a ⇒ b (a) *greater than*, (b) *less than*, or (c) *the same as* the work done by the gas in process c ⇒ d? _____
Explain your reasoning.

C3-CT41: Pressure–Volume Graph for Various Processes—Work

An ideal gas is trapped in a cylinder with a piston. Eight states of the gas are labeled *a*–*h*, and eight processes between these states are shown as solid lines with arrows.



(a) Is work done by the gas for the process $a \Rightarrow b$ (i) *greater than*, (ii) *less than*, or (iii) *equal to* the work done by the gas for the process $e \Rightarrow f$? _____

Explain your reasoning.

(b) Is work done by the gas for the process $b \Rightarrow c$ (i) *greater than*, (ii) *less than*, or (iii) *equal to* the work done by the gas for the process $f \Rightarrow g$? _____

Explain your reasoning.

(c) Is work done by the gas for the process $a \Rightarrow b \Rightarrow c \Rightarrow d$ (i) *greater than*, (ii) *less than*, or (iii) *equal to* the work done by the gas for the process $e \Rightarrow f \Rightarrow g \Rightarrow h$? _____

Explain your reasoning.

(d) Is total work done by the gas for the cyclic process $a \Rightarrow b \Rightarrow c \Rightarrow d \Rightarrow a$ (i) *greater than*, (ii) *less than*, or (iii) *equal to* the total work done by the gas for the process $e \Rightarrow f \Rightarrow g \Rightarrow h \Rightarrow e$? _____

Explain your reasoning.

C3-LMCT42: Carnot Heat Engine I—Efficiency

A Carnot heat engine operating between 727 °C and 127 °C takes in 2,000 J from the hot reservoir and exhausts 800 J to the cold reservoir.

Identify from choices (i)–(iv) how each change (a) to (e) described below will affect the efficiency of the heat engine as compared to the initial efficiency.

This change will cause the *efficiency* of this Carnot heat engine:

(i) to ***increase***.
(ii) to ***decrease***.
(iii) to *remain the* ***same***.
(iv) to be ***indeterminate***.

All of these modifications are individual changes to the initial situation.

(a) The temperature of the hot reservoir (727 °C) is increased. _____
Explain your reasoning.

(b) The temperature of the cooler reservoir (127 °C) is increased. _____
Explain your reasoning.

(c) Energy taken into the engine (2000 J) is increased. _____
Explain your reasoning.

(d) The temperatures of the hot reservoir and cool reservoir are increased by the same amount. _____
Explain your reasoning.

(e) The temperature of the hot reservoir is increased while the temperature of the cool reservoir is decreased by the same amount. _____
Explain your reasoning.

C3-WWT43: Carnot Engine II—Efficiency

A newly designed engine operating between 727 °C and 127 °C takes in 5,000 J from the hot reservoir and exhausts 1,000 J at the lower temperature. A student states:

"This is a great new engine. The efficiency of a Carnot engine is 82.5% between those temperatures using $(T_h\text{-}T_c)/T_h$*, but this new engine has an efficiency of 80%, which is pretty close to the best possible Carnot engine between those temperatures."*

What, if anything, is wrong with this student's contention? If something is wrong, identify it and explain how to correct it. If nothing is wrong, explain why the statement is valid.