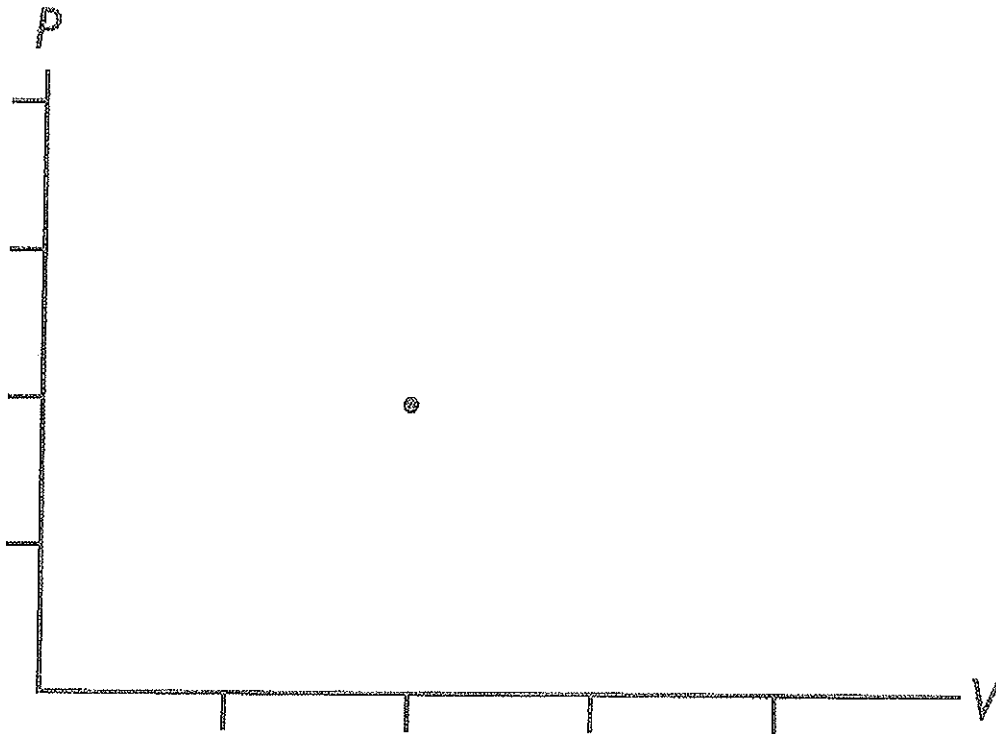


Physics Thermodynamics Tutorial

Question 1

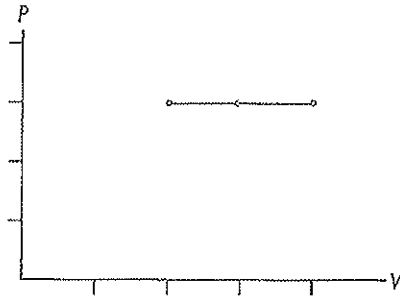
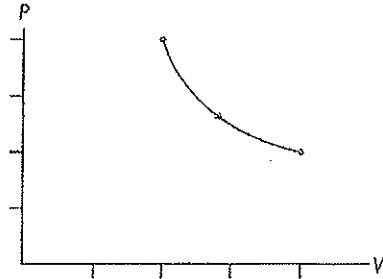
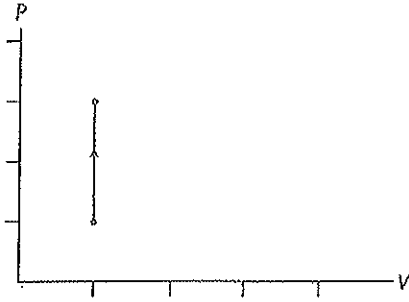
The graph below shows the initial state of a gas. On it, draw the following processes.

- An isochoric process that doubles the pressure.
- An isobaric process that doubles the temperature.
- An isothermal process that halves the volume.



Question 2

For the following PV diagrams, state the name of the process, the factors by which P , V and T change, and whether ΔE , Q and W are positive, negative or zero.



Process _____

P changes by _____

V changes by _____

T changes by _____

ΔE is _____

Q is _____

W is _____

Process _____

P changes by _____

V changes by _____

T changes by _____

ΔE is _____

Q is _____

W is _____

Process _____

P changes by _____

V changes by _____

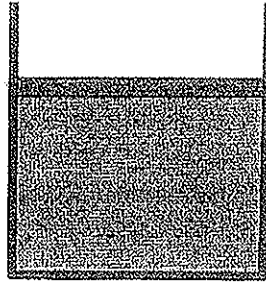
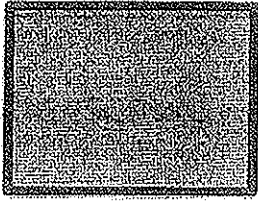
T changes by _____

ΔE is _____

Q is _____

W is _____

Question 3



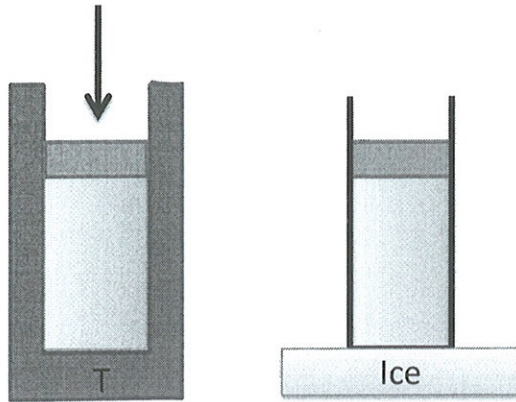
Two containers each contain one mole of neon at 350K. The containers are placed in cold water and slowly cooled to 275K, one at constant volume and the other at constant pressure. Compared to the amount of heat that flows out of the constant volume container (i.e. the magnitude of Q), the amount of heat that flows out of the constant pressure container is

- A) Larger
- B) Smaller
- C) The same

Explain.

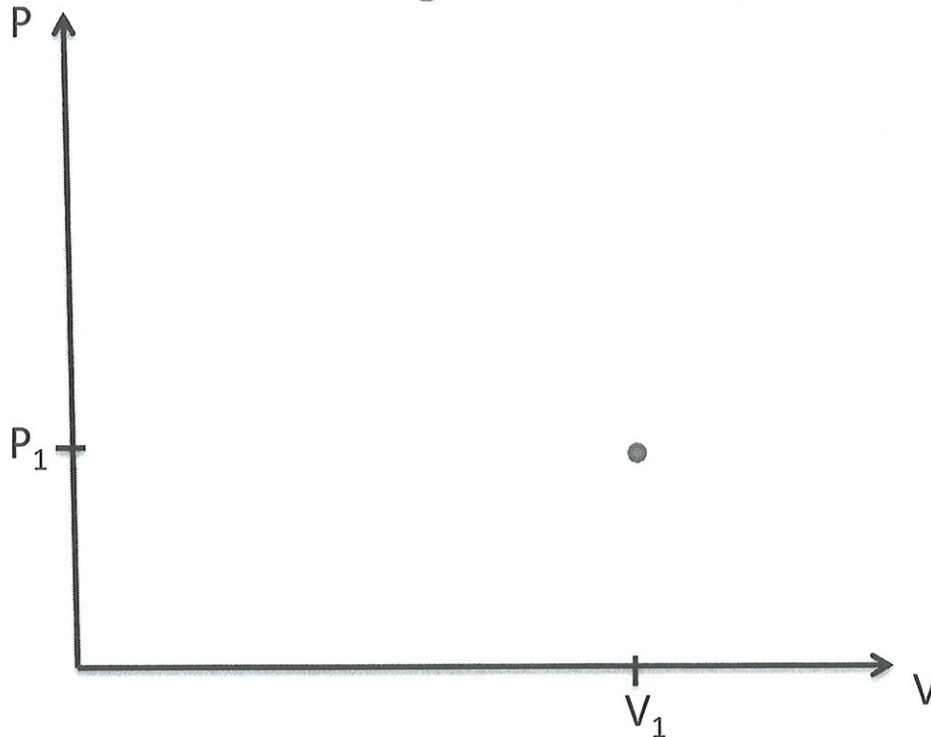
reminder: work done on the gas for a small change in volume is $-P\Delta V$. Why?

Question 4



Two containers each contain one mole of oxygen, each with the same initial volume, temperature, and pressure. One is compressed while being kept at constant temperature, while the other is cooled with a freely moving piston. If the volume of each decreases by the same amount, draw points on the graph below to represent the endpoint of each process and paths to indicate the intermediate stages for each process.

Hint: What is constant during the second process?



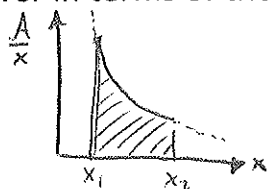
b) In terms of the initial volume V_1 and initial pressure P_1 , how much work is done on the gas during the process on the right with the free piston?

c) What is the area on the graph under the path you drew for this process?

d) Hopefully you found the same result for b and c: when a gas compresses at constant pressure, the work done on the gas is the area under the path on the PV graph. In fact, this holds for any process, even if the pressure isn't constant. Explain how you could show this (*Hint: for a more general process, the pressure will be almost constant for very small changes in volume*):

d) Calculate the work done on the gas in the constant temperature process on the previous page. Answer in terms of the initial volume V_1 and initial pressure P_1 .

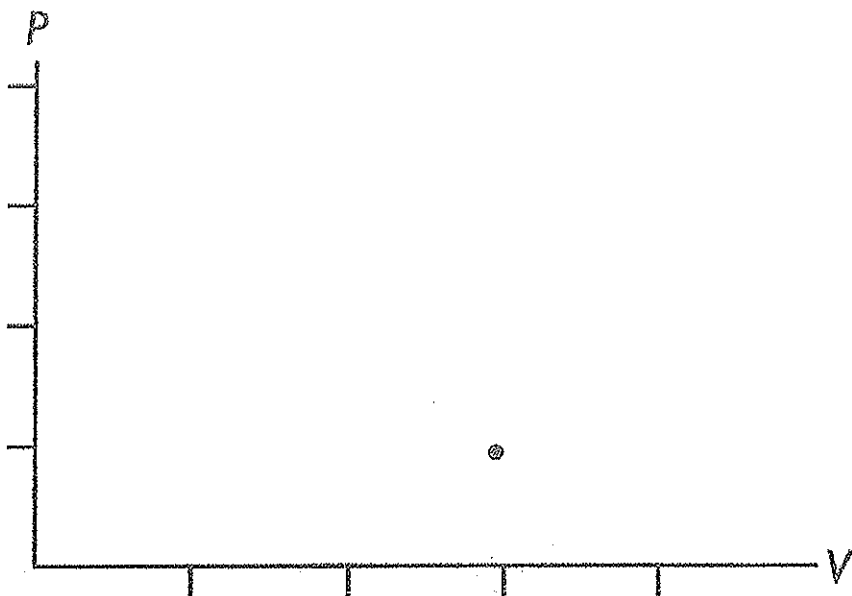
Hint:



The area under the graph of A/x from x_1 to x_2 is $\ln\left(\frac{x_2}{x_1}\right)$

Question 5

A cylinder of gas with a movable piston initially has a temperature T and pressure P . The gas is cooled slowly to a temperature $T/2$ while the piston is free to move. Then the piston is locked and the gas is heated back to a temperature of T . Finally, the piston is released, and the gas expands at a constant temperature back to its original volume.



- Draw the process on the graph above.
- For each segment with work done, calculate the work (with the correct sign)
- Calculate the heat added during the step where the temperature increases.
- What is the ratio of (net work done) / (heat added) for the cycle? Your answer should be in terms of R and C_V only.
 (in part c)