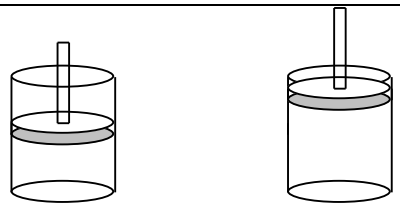
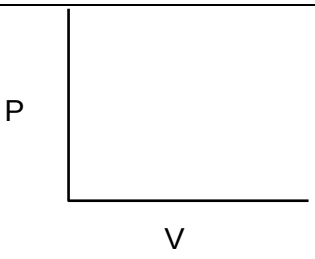
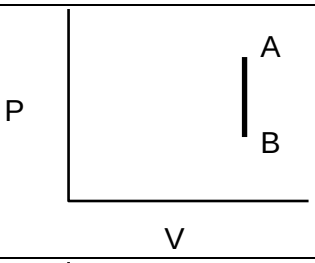
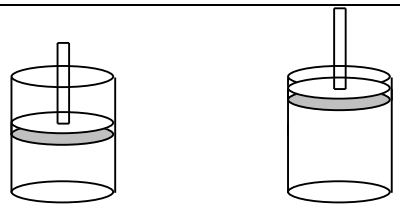
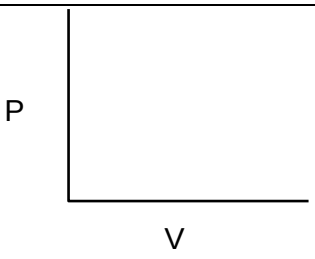
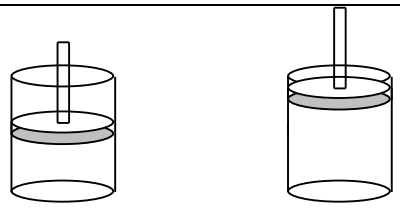
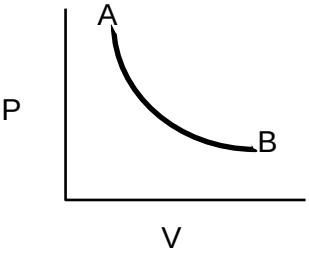
Physics 369 Name_____

An Introduction to P-V Graphs Date_____ Hour_____

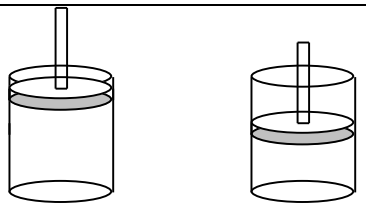
Directions: Several different situations that involve a movable piston in a cylinder are listed below. The piston is filled with a gas that may be heated and may be cooled. You will be asked to draw pistons, parts of graphs, or answer questions based on these eight experiments. Please realize that the horizontal rows all represent the same experiments.
After you have had the opportunity to try your hand at these experiments, the entire class will try to answer the questions.

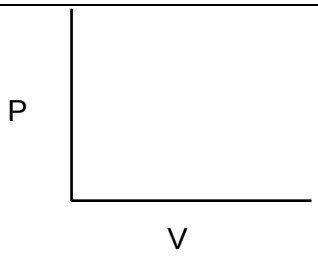
Experiment 1: In this case heat is added to the gas and the piston is moved up doing useful work. Notice that the volume increases. The pressure will remain the same because the heat is added to this system. Please draw the P-V graph for this system.		
Experiment 2: Here the system is cooled and the pressure drops as shown. Please draw the piston in the cylinder as you think it should appear at the start of the experiment and at the end.		
Experiment 3: In this case the pressure drops on the gas in the cylinder while the volume grows. If this takes place over a constant temperature, what is the process called and what does the P-V graph look like? NAME_____		
Experiment 4: In some situations, the pressure and volume can change in a manner similar to the above, but the temperature of the gas changes. In this graph, the process is called **adiabatic** because there is no exchange of heat with the surroundings. Would this process more likely take place over a long period of time or a short period of time? LONG SHORT		

Experiment 5: In this situation the piston is moved as shown. Would work be done by the piston in this case or would work have to be done to the piston?

BY IT **TO IT**

Finally, draw the P - V graph that describes this situation.





Experiment 6: In this situation the gas is moved through the P - V graph as shown. Describe how this could occur and draw in the appropriate pistons.

DESCRIBE_____
_____
_____
_____
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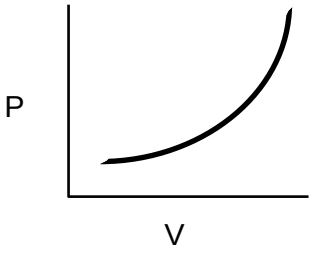
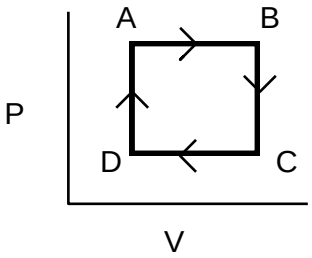


Experiment 7: In this situation, the gas is brought through a complete cycle as shown in the P -V graph. Draw the ending position of the piston. During what part of the cycle was work done **by** the piston? Circle all the correct choices.

From A to B
From B to C
From C to D
From D to A

During what part of the cycle was work done **to** the piston? Circle all the correct choices.

From A to B
From B to C
From C to D
From D to A



Experiment 8: In this final experiment, again a complete cycle is shown. Please fill in the pistons for all steps and indicate the temperature using the following terms:

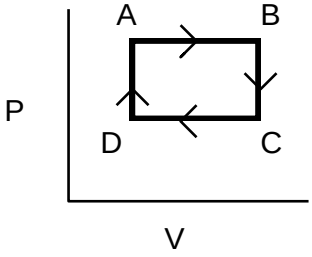
Hot
Warm
Cool
Cold

Is more work or less work done in this experiment than in **Experiment 7**? Circle your choice.

MORE LESS

Temp_____ Temp_____

Temp_____ Temp_____



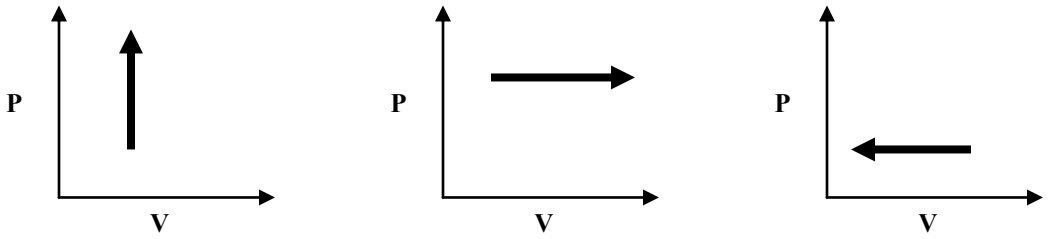
Physics 369 Name _____

P-V Graphs Homework Date _____ Hour _____

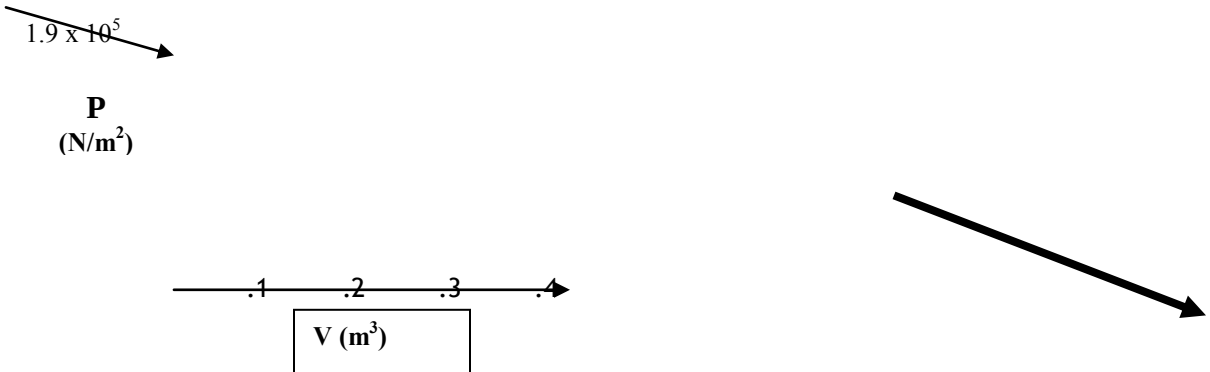
Answer all of the following questions. They are written in order of increasing difficulty, but continue to the end even if you get "stumped". All of these refer to a machine as was discussed in class.

1. First we will look at Work = Fd cos θ or, more applicable in our case, W = PΔV. How much work is done in each case shown below? Your Choices are:

   a. Work is done **BY** the gas (+)
   b. Work is done **TO** the gas (-)
   c. **NO** Work is done



2. How much work is involved in this process? Is it positive or negative?

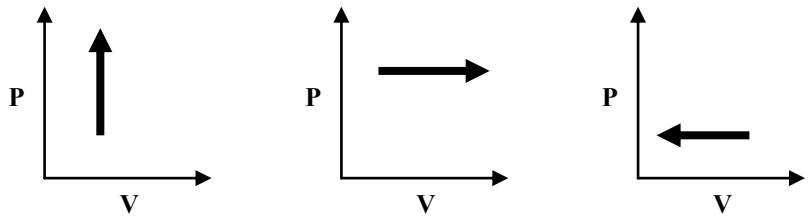


3. What would the answer [illegible] pointed in the opposite direction?

4. In general, if the arrow was the same length but lower on the graph, what would happen to the amount of work that you calculate?

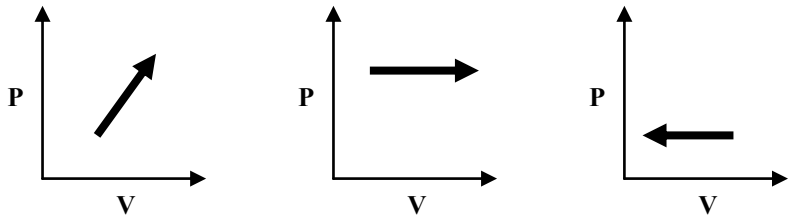
5. What does the length of the arrow do to the work you calculate?

6. How could you get each of the arrows shown below? Remember PV = nRT. Check all that apply in the table below.



Add Heat to the Gas			
Cool the Gas			

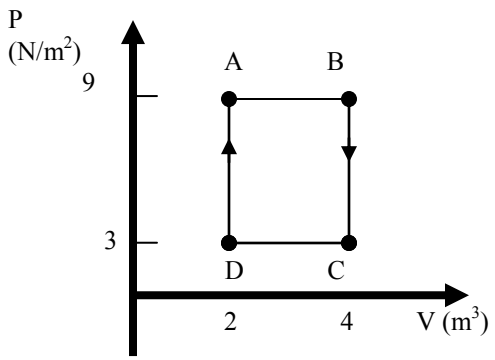
7. What would happen to each of these if heat was not added or taken away from the gas?



The internal energy (Temperature) would increase.			
The internal energy (Temperature) would decrease.			

Part Two - Time to put all of this together. You have answered questions about Work (W), Heat (Q) and Internal Energy (U). You will now use $W = Q - \Delta U$ to answer problems.

Given a gas that follows the path A→B→C→D→A as shown, fill in the chart at the right.



Path	W	Q	ΔU
A→B			+3 J
B→C		-6 J	
C→D			+1 J
D→A		+2 J	

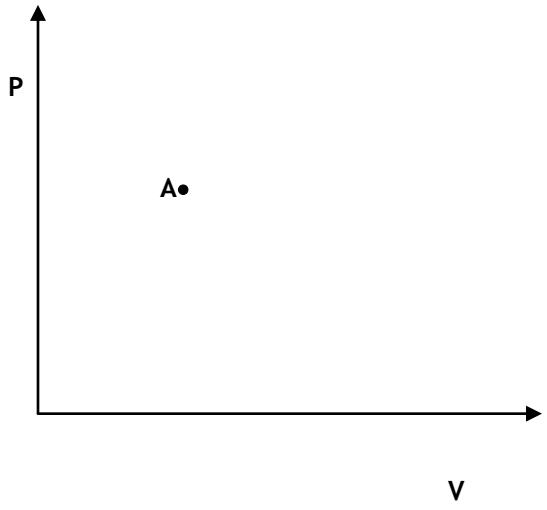
8. In an **adiabatic** process, what does NOT change?

9. In an **isothermal** process, what does NOT change?

10. In an **isobaric** process, what does NOT change?

11. In an **isovolumetric** (isochoric) process, what does NOT change?

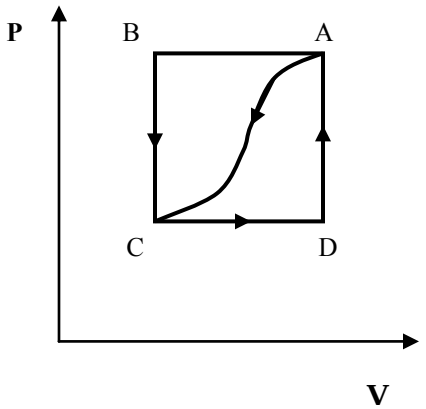
12. Draw a P-V graph for the following situation. A piston (initially at a Pressure and Volume given by **A** shown below) moves in a cylinder increasing the volume at a constant temperature. At some point **B** the gas stops increasing in volume then begins decreasing in volume **isobarically**. This continues until the volume matches that given at point **A**. Heat is then added to the system **isovolumetrically** to bring the pressure up to that listed in **A**.



13. Would the gas in the above process do work through the cycle or would the process require that work be done to the gas to accomplish what is described?

14. If the pressure varies from 1.2 to 1.9 kPa, and the volume varies from .05 to .92 m^3, estimate the net work accomplished in this process.

15. When a gas is taken from **A** to **C** along the curved path shown, the work done by the gas is W = -35 J and the heat added to a gas is Q = -63 J. Along path **ABC** the work done is W = -48 J. It might be best to use the chart at the right.



a) What is the Q for path **ABC**?

b) If $P_C = ½ P_B$, what is W for path **CDA**?

c) What is Q for path **CDA**?

d) What is $U_A - U_C$?

e) If $U_D - U_C = 5$ J, What is Q for path **DA**?

Path	W	Q	ΔU
A→B→C			
A→C			
C→D→A			
D→A			