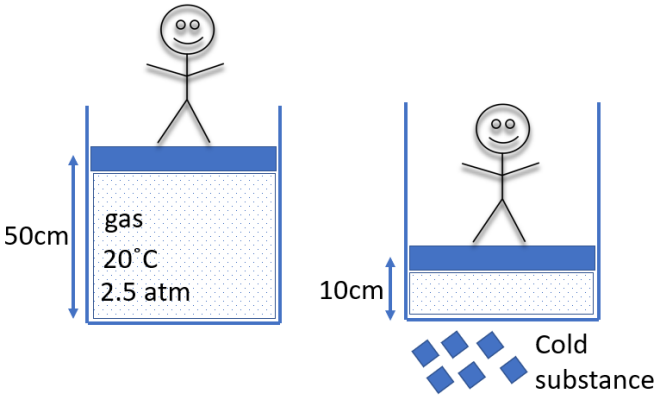
P20: Exam 3 practice Name:_____

Write directly on these sheets. Constants are at the end. You may use any calculator. You may use the 3×5 card if you brought one; staple it to the exam. The exam ends with word "END". The total score is 40pts.

Problem 1 (10 pts). You design a thermal elevator that is made of a cylinder with gas sealed by a piston of 40cm radius. When you stand on top of the piston at the height of 50cm, like shown in the left figure, the *absolute* pressure in the cylinder is 2.5 atm at 20˚C. Cold substance is then touched to the cylinder, making you descend slowly, as shown in the right figure, to the height of 10cm.



a) What is the final pressure of the gas in the cylinder (at the height 10cm)? Answer in atm.

b) What is the final temperature of the gas in the cylinder (at the height of 10cm)?

c) How much work is done *on* the gas as you descend from 50cm to 10cm. Answer in J, with the correct sign.

d) What kind of process is the gas undergoing? Circle one: a) isovolumetric, b) isobaric, c) isothermal, d) adiabatic? Sketch the process on the pV diagram. Draw a curve with an arrow (no numbers).

e) Can the number of moles of the gas be determined? If so, answer in moles. If not, what else would you need to determine it?

Problem 2 (6 pts). You drop 0.1kg of -20˚C ice into 0.5kg of 20˚C soda. Assume the drink is in a perfectly insulating thermos.

a) How much heat is needed to melt all the ice and reach 0˚C? Answer in J

b) How much heat would be released from the soda if it were to cool to 0˚C but not freeze? Answer in J.

c) Based on your answers, will all the ice melt? Explain briefly.

Problem 3 (6 pts). In an isobaric process on 1.0 mol of air in a cylinder sealed by a piston, 400J of energy is transferred by heat into air while the air does +100J of work. The air is initially at 27˚C. The specific heat of air is 1J/g and molar mass 28.8g/mol.

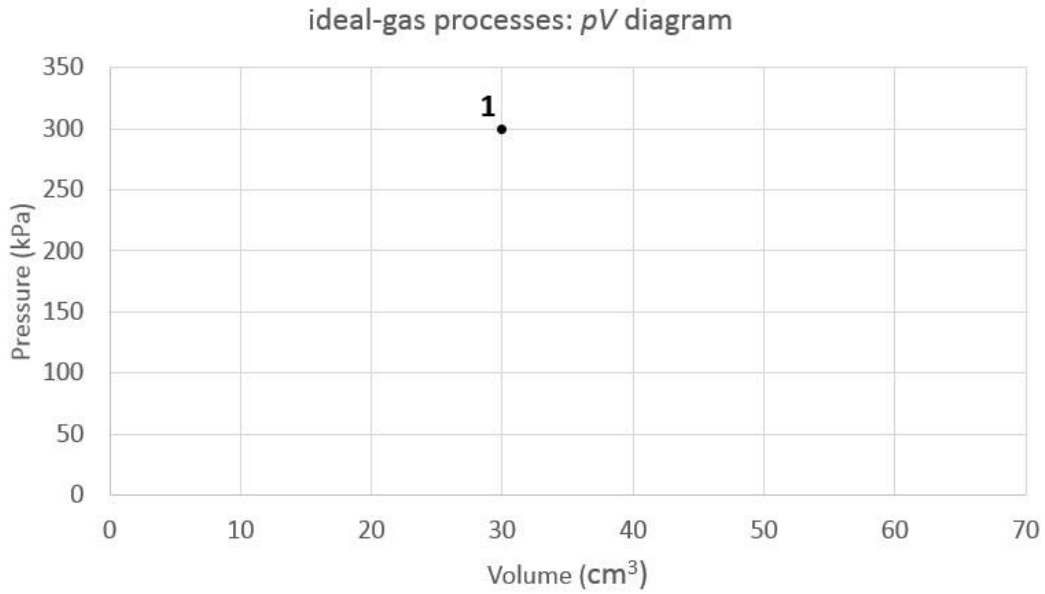
a) Circle One: Is the volume expanding or compressing?

b) What is the change in internal energy of the air? Answer in J

c) What is its final temperature?

d) What is the efficiency of this process? Answer in percent.

Problem 4 (13 pts). 0.0012 mols of air are sealed (*n* cannot change) by a movable piston in a cylinder initially at 30cm^3 and 300 kPa. This point is represented by "1" on the *pV* diagram below. Note the units.



1pts a) What is the temperature at “1”? Answer in Kelvins.

2pts b) Into the same *pV* diagram, draw a curve (with an arrow) representing *an isobaric* process that *doubles* the volume; label this end-point as “2”.

2pts Find the work from “1” to “2”. Answer in Joules and clearly indicate the sign.

1pts c) into the same *pV* diagram, draw a curve representing an *isochoric* process that starts at “2” and *reduces* the pressure by a factor of *three*. Label the end-point as “3”.

2pts Find the work from “2” to “3”. Answer in Joules.

2pts What is the temperature at “3”? Answer in Kelvin.

d) into the same *pV* diagram, draw a curve (or two) representing one (or more) processes, such that you end up back at “1” and the *net* work done by the gas will be +6J on the closed cycle.

Multiple Choice (1pt each)

1. A container with a one-liter capacity at 83° C is filled with helium to a pressure of 2.0 atm. (1 atm = 1.0 × 10^5 N/m2.) How many moles of helium does it hold?

A. 1.3
B. 0.35
C. 0.068
D. 0.081
E. 0.091

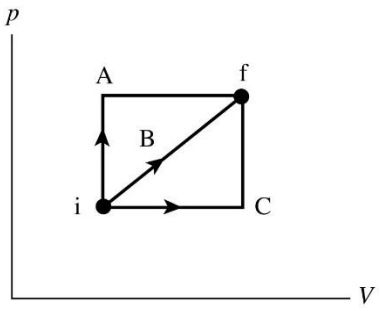
2. A constant volume gas thermometer has a pressure of 3.00 atm at 100°C. What would its pressure be at 0°C?

A. More information is needed to find the answer
B. 1.00 atm
C. 1.17 atm
D. 2.20 atm
E. 1.46 atm

3. The outside pressure on a nice day near a lake is 101.3 kPa. What is the absolute pressure on a diver at a depth of 40m inside lake?

A. -392.4 kPa
B. -101.3 kPa
C. +101.3 kPa
D. +392.4 kPa
E. +493.7 kPa

4.Three possible processes A, B, and C take a gas from state i to state f. For which process is the heat transfer the largest?



A. Process A
B. Process B
C. Process C
D. The heat is the same for A and C and the lowest in B.
E. The heat is the same for all three processes

5. You have a well-sealed and well-insulated 100 cm^3 box of helium and a 100 cm^3 box of argon. Both gases have the same (non-zero) pressures and the same mass. How does the helium temperature compare to the argon temperature?

A. $T_{He} > T_{Ar}$
B. $T_{He} = T_{Ar}$
C. $T_{He} < T_{Ar}$
D. $T_{He} = T_{Ar} = 0$ K
E. Not enough info to compare *T*.

-- END --

sphere volume $V = \frac{4}{3}\pi R^3$
gas constant *R* = 8.31 J/mol/K
density of water 1000kg/m^3
1 Liter = $10^{-3} m^3$
1atm = 101kPa

specific heat of water 4186 J/kg ˚C
specific heat of ice 2108 J/kg ˚C
latent heat of fusion for ice 334 J/g