



Center for Academic Resources in Engineering (CARE) Peer Exam Review Session

Phys 213 — University Physics: Thermal Physics

Final Worksheet

The problems in this review are designed to help prepare you for your upcoming exam. Questions pertain to material covered in the course and are intended to reflect the topics likely to appear in the exam. Keep in mind that this worksheet was created by CARE tutors, and while it is thorough, it is not comprehensive. In addition to exam review sessions, CARE also hosts regularly scheduled tutoring hours.

Tutors are available to answer questions, review problems, and help you feel prepared for your exam during these times:

Session 1: April 25, 8-10pm Jay and Greg Session 2: None

Can't make it to a session? Here's our schedule by course:

<https://care.engineering.illinois.edu/tutoring-resources/tutoring-schedule-by-course/>

Solutions will be available on our website after the last review session that we host, as well as posted in the zoom chat 30 minutes prior to the end of the session

Step-by-step login for exam review session:

1. Log into [Queue @ Illinois](#)
2. Click "New Question"
3. Add your NetID and Name
4. Press "Add to Queue"
5. Join the zoom link in the staff message

Please do not log into the zoom call without adding yourself to the queue

Good luck with your exam!

If studying for Quiz 2, please skip problems 5 and 10-15. These questions will only be covered on the Final Exam. Problems 11, 12, and 13 on Worksheet 1 will also be covered on Quiz 2.

1. Which conditions are held constant in the following processes? (Refer to the formula sheet if you are not sure!)
 - a) Isothermal
 - b) Isobaric
 - c) Isochoric
 - d) Adiabatic
2. What is the relationship between volume and pressure during isothermal and adiabatic processes for an ideal gas, respectively?

The following two questions refer to the setup described below.

A piston of volume 0.05 m^3 contains 5 moles of a monatomic ideal gas at 300 K. If it undergoes an isothermal process and expands until the internal pressure matches the external pressure, $P_E = 1 \text{ atm}$.

3. How much work is done by the gas on the environment?
 - a) 7.42×10^3
 - b) 1.13×10^4
 - c) -1.13×10^4
 - d) 1.83×10^4
 - e) -1.83×10^4
4. Suppose that the piston undergoes an adiabatic expansion instead, what is the final volume of the piston, V_f ? (Values have units of cubic meters)
 - a) 0.086
 - b) 0.095
 - c) 0.123

5. What is the difference between Helmholtz free energy and Gibbs free energy? In which situations would you use one over the other?
6. When a system is colder than the temperature of the environment (i.e. $T_{sys} < T_{env}$) its free energy is:
 - a) Smaller than its value when $T_{sys} = T_{env}$
 - b) Larger than its value when $T_{sys} = T_{env}$
 - c) The same as its value when $T_{sys} = T_{env}$
7. The second law of thermodynamics states that the change in entropy is always greater than or equal to zero, yet sometimes in our calculations we can get a negative entropy for a piece of our system. What does a negative entropy represent? And how do negative entropies not violate the second law?
8. Using the second law of thermodynamics, show that it is impossible for a heat engine to operate at $\epsilon = 1$.
9. A Carnot heat engine (one operating at maximum efficiency) is operating between two reservoirs at T_H and T_C . Suppose that 1 kJ of heat must be added to the engine in order to produce 500 J of work and you measured the temperature of the cold reservoir to be 300 K, what is the temperature of the hot reservoir?
 - a) 150 K
 - b) 200 k
 - c) 300 K
 - d) 450 K
 - e) 600 K

10. Given an internal energy function $U(N) = \sin(N^2) + \ln(\alpha N)$ and an entropy function $S(N) = Ne^N$ determine the chemical potential as a function of N (T is constant).
11. Show that $-T\left(\frac{dS}{dN}\right)_{U,V} = \left(\frac{dF}{dN}\right)_{T,V}$ using the fundamental relation.
12. A heat pump uses 200 J of work to remove 300 J of heat from a cold reservoir. How much heat would be delivered to the hot reservoir?
13. Describe the difference between chemical equilibrium and thermal equilibrium.
14. Why does adding salt on the sidewalks in winter prevent ice from forming?
15. How does the phase diagram for water differ from other pure substances?