Core Science 221, Section 1 **NAME:**

Homework 4: Thermodynamics: Homeworks are due as posted on the course web site. Enter the answer to the multiple-choice questions on the answer table beside the number corresponding to the question. There may be gaps in the table when full-answer questions appear in the homework. You only need to hand in the table for the multiple-choice questions. Solutions will be posted eventually after the due date.

Answer Table

Name:

	a	b	c	d	e		a	b	c	d	e
1.	O	O	O	O	O	31.	O	O	O	O	O
2.	O	O	O	O	O	32.	O	O	O	O	O
3.	O	O	O	O	O	33.	O	O	O	O	O
4.	O	O	O	O	O	34.	O	O	O	O	O
5.	O	O	O	O	O	35.	O	O	O	O	O
6.	O	O	O	O	O	36.	O	O	O	O	O
7.	O	O	O	O	O	37.	O	O	O	O	O
8.	O	O	O	O	O	38.	O	O	O	O	O
9.	O	O	O	O	O	39.	O	O	O	O	O
10.	O	O	O	O	O	40.	O	O	O	O	O
11.	O	O	O	O	O	41.	O	O	O	O	O
12.	O	O	O	O	O	42.	O	O	O	O	O
13.	O	O	O	O	O	43.	O	O	O	O	O
14.	O	O	O	O	O	44.	O	O	O	O	O
15.	O	O	O	O	O	45.	O	O	O	O	O
16.	O	O	O	O	O	46.	O	O	O	O	O
17.	O	O	O	O	O	47.	O	O	O	O	O
18.	O	O	O	O	O	48.	O	O	O	O	O
19.	O	O	O	O	O	49.	O	O	O	O	O
20.	O	O	O	O	O	50.	O	O	O	O	O
21.	O	O	O	O	O	51.	O	O	O	O	O
22.	O	O	O	O	O	52.	O	O	O	O	O
23.	O	O	O	O	O	53.	O	O	O	O	O
24.	O	O	O	O	O	54.	O	O	O	O	O
25.	O	O	O	O	O	55.	O	O	O	O	O
26.	O	O	O	O	O	56.	O	O	O	O	O
27.	O	O	O	O	O	57.	O	O	O	O	O
28.	O	O	O	O	O	58.	O	O	O	O	O
29.	O	O	O	O	O	59.	O	O	O	O	O
30.	O	O	O	O	O	60.	O	O	O	O	O

1. "Let's play *Jeopardy*! For $100, the answer is: It is the science of the thermodynamic state of systems. This state is characterized or defined or determined by thermodynamic variables which include heat energy (properly internal energy), temperature, pressure, volume, density, mass, entropy, phase, and many others too. These variables are functions of the thermodynamic state and are called state functions: they are independent of the history that resulted in the thermodynamics state. Energy transformation most importantly heat flow and macroscopic work done are part of the science. The science encompasses both thermodynamic equilibrium and non-equilibrium states. In modern version of the science, the average microscopic state of the system and how it determines the macroscopic variables mentioned above is included."

   What is _____, Alex?

   a) kinematics b) cinematics c) dynamics d) dynastics e) thermodynamics

2. "Let's play *Jeopardy*! For $100, the answer is: It is the sum of all microscopic forms of energy: these include kinetic energy, potential energy, electromagnetic radiation energy, and magnetic field energy. Microscopic means that these energies do not manifest themselves in macroscopic ordered structures."

   What is _____, Alex?

   a) kinetic energy b) internal or heat energy c) potential energy d) elastic energy
   e) cinematic energy

3. They are macroscopic observables that are functions of the thermodynamic state of matter. Observable means that the quantity can be measured by means in which we have complete theoretical confidence. After all we do not measure, for example, temperature directly, but rather, for example, the volume of alcohol in an alcohol thermometer. To be deeply philosophical for a moment, we only observe our sense perceptions directly and everything else depends on our theoretical understanding of what we perceive. In the jargon of the philosophy of science, observations are theory laden. Nevertheless, by custom we say we observe things where we have complete confidence in the theory of those things. Where our theoretical confidence is less than complete, we sometimes talk model-dependent results or indirect observations. To end this digression, the observables we were talking about are sometimes called state functions, but the author prefers:

   a) quantum mechanical observables. b) factors. c) global factors.
   d) thermodynamic variables. e) thermodynamic temperatures.

4. Three well known thermodynamic variables (i.e., state functions) are volume, density, and:

   a) pressure. b) force. c) work. d) relaxation. e) recreation.

5. "Let's play *Jeopardy*! For $100, the answer is: In one definition, it is a measure of the average internal energy per degree of freedom of a single particle (e.g., an atom, molecule, electron, or photon [though they are a bit of a special case])."

   What is _____, Alex?

   a) pressure b) volume c) temperature d) entropy e) entity

6. The three common temperature scales are:

   a) Fahrenheit, Celsius, and Kelvin. b) Fahrenheit, Celsius, and Newton.
   c) Fahrenheit, Vesuvius, and Kelvin. d) Fahrenheit, Celsius, and Calvin.
   e) Gesundheit, Vesuvius, and Calvin.

7. When all the removable kinetic energy of a system (e.g., a sample of material) has been removed, the system is at:

   a) absolute zero temperature. b) relative zero temperature. c) $-40°$C. d) $-40°$F.
   e) 273.15 K.

8. Formally, it is a internal energy transfer. But many people use it as a synonym for internal energy at least when speaking loosely. We are speaking of:

   a) work. b) heat. c) force. d) entropy. e) pressure.

9. The three common heat transfer processes are:

a) conduction, invection, and radiative transfer. b) induction, convection, and radiative equilibrium. c) conduction, convection, and radiative transfer. d) conduction, invection, and radiative equilibrium. e) introduction, insurrection, and radiative hibernation.

10. "Let's play *Jeopardy*! For $100, the answer is: It is a state of a system of unchanging thermodynamic behavior at the macroscopic level: i.e. pressure, temperature, density, phase, and entropy are unchanging. Entropy is in fact at the maximum allowed by the nature and the available internal energy. At the microscopic level, there is continual change going on. But the atoms and molecules have a distribution of behavior, but the distribution itself is unchanging, and in particular the average behavior is unchanging. The state is a timeless state that could be called at dead state since life (as we know it) cannot exist in this state when it is fully enforced."

    What is _____, Alex?

    a) hydrostatic equilibrium b) mimimum entropy c) heat flow
    d) thermodynamic equilibrium e) ennui

11. If two bodies are in thermodynamic equilibrium with a third body, they are in thermodyamic equilibrium with each other. By being in thermodyamic equilibrium, we mean that if put in thermal contact where heat flows can occur, no macroscopic heat flows will occur and no thermodynamic variables will change. The first statement is the:

    a) zeroth law of thermodynamics. b) first law of thermodynamics.
    c) second law of thermodynamics. d) third law of thermodynamics.
    e) fourth law of thermodynamics.

12. In the the zeroth law of thermodynamics, the third body acts in part like _____ since it acts as a measurer of thermodynamic equilibrium states.

    a) a rock b) a power station c) a thermometer d) a turbine e) the Third Man

13. "Let's play *Jeopardy*! For $100, the answer is: It is the 1st law of thermodynamics (in less than most general form), as expressed as formula."

    What is _____, Alex?

    a) $W = Q + \Delta E$ b) $\Delta E = Q - W$ c) $E = \frac{1}{2}mv^2$ d) $E = mv^2$ e) $E = mc^2$

14. When one discusses work in thermodynamics, one usually means work done by:

    a) entropy. b) pressure. c) temperature. d) density. e) horses.

15. Gas pressure is caused by the _____ of atoms and/or molecules.

    a) cohesion b) suction c) collisions d) chemical bonds e) neutrons

16. Aerodynamic lift is an non-static-air air pressure effect with two main identifiable components:

    a) a wing and a prayer. b) entropy and reaction lift. c) entropy and temperature.
    d) reaction lift and Carnot lift. e) reaction lift and Bernoulli lift.

17. Take this quiz and . . .—no, no not that. Take this quiz—or some single sheet of paper if you arn't in a quiz *mise en scène*—in your fingers with your fingers on either side of one of narrow ends. Hold this end just **BELOW** your lips and blow a strong gust.

    a) Nothing happens, because you've blown too hard.
    b) Nothing happens, because you've blown too softly and you've never succeeded in blowing up a balloon in your life.
    c) You spit.
    d) The instructions are unintelligible.
    e) The paper rises because you've created a high-speed, low-pressure zone above the paper. Below the paper is normal pressure. The pressure force inequality will push the paper upward against the force of gravity. The overall effect is the Bernoulli lift which is part of aerodynamic lift by which airplanes fly. Of course, if you put the paper above your lips and blow the paper rises too. This time it is the reaction lift which is the other part of aerodynamic lift. The blown air is deflected

down by the paper, but for every force there is an equal and opposite force and so the air pushes up on the paper too.

18. In *2001: A Space Odyssey*, astronaut David Bowman finds himself trapped without his helmet in a space pod. The computer Hal has locked the direct pod-to-space-ship airlock. Bowman decides to "breathe vacuum"—to go sans helmet through space to an outside airlock—and then deal with Hal. Why doesn't Bowman explode due to his internal body pressure in the nearly zero pressure of space?

    a) He is too quick to explode.
    b) He holds his breath.
    c) Hal has not anticipated Bowman's maneuver or at least has no contingency plan.
    d) Sheer plot requirement.
    e) Most of the body's internal pressure is supplied by nearly incompressible (and therefore nearly non-expandable) fluid and solid: these parts won't explode under decompression. The solid and liquid parts are strong enough it seems to keep the air in the body cavities contained. One doesn't hold one's breath and one hopes one's eardrums don't rupture.

19. "Let's play *Jeopardy*! For $100, the answer is: He introduced the concept of entropy."

    Who is _____, Alex?

    a) Ptolemy (circa 100–175 CE) b) Nicolaus Copernicus (1473–1543)
    c) Isaac Newton (1642/3–1727) d) Rudolf Clausius (1822–1888)
    e) Stephen Hawking (1942–)

20. The thermodynamic variable entropy is a quantitative measure of:

    a) order. b) microscopic order. c) microscopic disorder. d) macroscopic disorder.
    e) temperature.

21. "Let's play *Jeopardy*! For $100, the answer is: They are the cause of increasing disorder."

    What are _____, Alex?

    a) Rambo or Rambolizing processes b) rambling or rambilizing processes
    c) rotational or rotationalizing processes d) rational or rationalizing processes
    e) random or randomizing processes

22. "Let's play *Jeopardy*! For $100, the answer is: The entropy of a thermodynamically closed (or isolated) system never decreases. Random processes if present will in fact drive a closed system to the state of maximum entropy allowed by the system's nature and available internal energy."

    What is _____, Alex?

    a) zeroth law of thermodynamics b) first law of thermodynamics
    c) second law of thermodynamics d) third law of thermodynamics
    e) fourth law of thermodynamics

23. The second law of thermodynamics **FORBIDS**:

    a) heat to flow spontaneously from hot to cold.
    b) heat to flow spontaneously from cold to hot.
    c) entropy to increase in a closed system.
    d) entropy to increase in an open system.
    e) entropy to decrease in **ALL** cases.

24. As a system's temperature approaches absolute zero, its entropy (and thus its maximum possible entropy) approaches zero or at least a minimum value possible for the system. This rule is called the _____. The _____ implies somehow that absolute zero temperature cannot be reached for a macroscopic system.

    a) zeroth law of thermodynamics. b) 1st law of thermodynamics.
    c) 2nd law of thermodynamics. d) 3rd law of thermodynamics.
    e) 4th law of thermodynamics

25. "Let's play *Jeopardy*! For $100, the answer is: Solid, liquid, gas."

    What are _____, Alex?

a) the three laws of thermodynamics b) the last three real substances c) the chemical categories d) the three main phases of matter e) the three least important phases of matter

26. The least dense phase of matter at a given temperature and pressure is usually:

a) gas. b) liquid. c) solid. d) none of the above. e) all of the above.

27. Bulk phase changes (i.e., not just changes at the surfaces of samples) for pure substances happen at definite temperatures which are:

a) all above 273.15 K. b) all below 273.15 K. c) all below 273.15 K and independent of pressure. d) independent of pressure. e) dependent on pressure in general.

28. A common substance that has no liquid phase at ordinary air pressure is carbon dioxide (CO_2). The solid phase is commonly called:

a) impossible green. b) sublimium. c) dry ice. d) marsh gas. e) Irish dirt.

29. "Let's play *Jeopardy*! For \$100, the answer is: It is the movement of water through the Earth's atmosphere and on its land and water surfaces and subsurfaces. An outline of the process is as follows. Solar energy evaporates liquid water from the water surfaces and causes convection and vertical and horizontal movement in the atmosphere of water vapor. The vapor precipitates out as rain or snow or hail. Usuually as a liquid water flows downhill then and at least some of it reaches the oceans. There are also large amounts of water in the form of ice some of which is also flowing slowly downhill. The whole process is also called the hydrological cycle."

What is the _____, Alex?

a) heat engine cycle b) bicycle c) ice cycle d) last real cycle e) water cycle

30. The three main phases of matter for a single substance can exist together **IN THERMODYNAMIC EQUILIBRIUM** only:

a) at absolute zero. b) at a triple point. c) below 273.15 K. d) above 273.15 K. e) with Macaques.

31. "Let's play *Jeopardy*! For \$100, the answer is: Among mammals, not the largest (the blue whale), not the smallest (the Etruscan shrew), not the fastest (the cheetah), nor the slowest (the sloth), not the most magnificent (the lion), not the noblest (the horse), not the most good-natured (the llama), nor the proudest (the camel), not the busiest (the beaver), not the growliest (the grizzly bear), not the tallest (the giraffe), not even the most sexed (the bonobo), nor the least (the giant panda), not the smelliest (the skunk beating out the billygoat), not the most loyal (the dog though this may be an over-rating), nor the most self-satisfied (the domestic cat [felis silvestris catus smugisimus]), not the lonesome flyer (the bat), nor the most spade-handed (the mole), not the wiliest (the coyote, but maybe they are only faux wily), nor the least (the guinea pig), not the flittiest (the gazelle), not the shyest (the wild deer), nor the most shattering (the proverbial bull in a china shop: AKA Raging Bull), not the most playful (the otter or the dolphin: take your pick), not the most clever (the fox who is also most into chicken coops and sour grapes), not the prickliest (the porcupine), not even the most thieving (the raccoon), and certainly not the most moon-child (the opossum)—

not the most cheese-loving (the mouse),
nor the quiestest (the church mouse),
not the maddest (the March Hare on the authority of Alice),
not the most obstinate (the mule: but maybe hybrids don't count),
not the most alpha-male (the He-Gorilla),
not the cheekiest (the squirrel),
nor the most hypocritical (we've all heard of weasel words)

—not the most striped (the zebra), nor the spottiest (the leopard), and not the most orange (the orangutan—provided artificial means are ruled out), not the most north polar (the muskox), nor the most Himilayan (the yak), not the most burning bright in the forest of the night (the tiger), nor even the most omnivorous (the pig probably), not the loneliest (the Lone Wolf), nor the most wère (the She-Wolf of London), not the most left-over from another age (the platypus), not the most conformist (the sheep), nor the least (the Rogue Male Elephant), perhaps the brainiest (but we'll see at the end of

the day), not the most extremely bipedal (the kangaroo), not the closest cousin (the Neanderthal), nor the smallest cousin (Homo Floresiensis)—

not the most mythical (the unicorn),
nor the most binatured (the centaur),
nor yet the most sublime (the gryphon though you'd never know it),
not the most alluring/fatale singer on the rocks (the siren),
not the most selfish elfish (the elf),
and not the most alto soprano in the choir (the angel),
nor yet the most fallen (the devil—though a close second by all accounts),
not the most Irish (the leprechaun),
not the most respectable (the hobbit),
nor yet the most bare-bottomed (the cherub)

—not the most rodent-like non-rodent (the chihuahua), not the most disgustingly hairless (the Mexican hairless), nor the only one without a tail (the Manx cat sometimes), not the most pointed (the stag), not the longest horned (the narwhal—in fact, not horned at all), not the most hunted horn (the rhinoceros), not the best wallower (the water buffalo), not the most extinct (the mammoth), nor the least (the rat), not the most sacrificial (el toro in the arena), nor the most tender (the dams of all species caressing their young)—but the sweatiest."

What is the _____, Alex?

a) hedgehog b) lemur c) monkey d) satyr e) human