Conceptual Physics NAME:

Homework 2d Gases Homeworks are due usually a day after the corresponding textbook part/lecture is completed. Due dates will be announced in class. Multiple-choice problems will all be marked. **USE** the answer table for these problems. The rest of the homeworks will be marked for apparent completeness and some full-answer problems will/may be marked in detail. Make the full-answer solutions sufficiently detailed that the grader can follow your reasoning. Solutions will be posted eventually after the due dates. The solutions are intended to be (but not necessarily are) super-perfect and often go beyond full answers. For an argument or discussion problem, there really is no single right answer. The instructor's answer reflects his long experience in physics, but there could be objections to his arguments, assumptions, nuances, style, facts, etc.

NAME:

Answer Table for the Multiple-Choice Questions

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

1. "Let's play *Jeopardy*! For \$100, the answer is: It is one of the three classical phases of matter. It is fluid phase in that the material has very little resistance to shear stresses (i.e., forces that try to change shape without changing volume. In comparison to liquids (which are also fluids), the resistance to shear stresses is tiny to vanishing. Unlike liquids, the phase in question has its atoms/molecules far apart and only touching during collisions. Consequently, the phase in question is usually much lower in density than solids or liquids and much more compressible. When pressure and temperature exceed certain values called the critical values, there is no distinction between the phase in question and liquid: no interface can be formed separating two phases. This kind of fluid is called a supercritical fluid."

   What is a ____________, Alex?

   a) spirit b) concrete c) plasma d) blas e) gas

2. If one continually raises the temperature of a material at constant pressure, it will become and stay a ____________. Note here, we consider plasma just an ionized ____________.

   a) solid b) liquid c) gass d) air e) blas

3. The Earth's atmosphere is an ocean of gas with the Earth's surface (solid and liquid) at the bottom. The gas (which is called air) is:

   a) a compound. b) a monatomic gas. c) a mixture. d) mostly oxygen. e) helium.

4. The table below gives the composition of dry air.

Dry Air Composition of Air

Order	Substance	Percentage by Number	Percentage by Mass
1	N_2 (molecular nitrogen)	77	75.52
2	O_2 (molecular oxygen)	21	23.14
3	Ar (argon)	0.99	1.29
4	CO_2 (carbon dioxide)	0.033	0.05
5	Ne (neon)	0.0018	0.0013
6	He (helium)	5.2×10^{-4}	7×10^{-5}
7	CH_4 (methane)	1.5×10^{-4}	1×10^{-4}
8	Kr (krypton)	1.1×10^{-4}	3×10^{-4}
7	H_2 (molecular hydrogen)	5×10^{-5}	...
8	O_3 (ozone)	4×10^{-5}	...
9	N_2O (nitrous oxide)	3×10^{-5}	...
10	CO (carbon monoxide)	1×10^{-5}	...
11	NH_3 (ammonia)	1×10^{-6}	...
...	H_2O (water vapor)	typically 1 to 4 at surface	

NOTE.—Since water vapor is very variable, it is not included in the dry air composition with the other substances, and so they add up to 100 % without water vapor. Dry air composition for the major components is fairly constant everywhere in the atmosphere.

   All the substances in the table have some importance for the biosphere, except probably for the noble gases argon, neon, and krypton is chemically nearly inert. For example, ____________ is directly essential for photosynthesis.

   a) N_2 b) O_2 c) Ar d) CO_2 e) Ne

5. At 20°C and 1 atm (101.325 kPa) pressure, dry air has a density of:

   a) 1.2041 kg/m^3. b) 1204.1 kg/m^3. c) 1000 kg/m^3. d) 7.874 kg/m^3. e) 7874 kg/m^3.

6. The density of air at 20° and 1 atm pressure is 1.21 kg/m^3 (HRW-323). (For comparison, water density under the same conditions is 998 kg/m^3 [HRW-323] which is nearly the frequently quoted 1000 kg/m^3 which is its density at 4° and 1 atm [CJ-322]) There is a room 5 m long, 4 m wide, and 3 m high filled with air. What is the mass of air in the room?

   a) 72.6 kg. b) 1.21 kg. c) 998 kg. d) 0 kg. e) −998 kg.

7. The pressure of the Earth's atmosphere at any level is caused by:

a) the weight of the overlying air mass. b) respiration by living things.
c) evaporation of sea water. d) glaciers. e) squid.

8. Because of its density ____________ pressure varies slowly with height and can usually can be taken as a constant over changes of height of a few meters or even hundreds of meters depending on how accurate you want to be.

   a) water b) air c) mercury d) iron e) lead

9. The pressure distribution formula for an incompressible fluid at rest near the Earth's surface is

$$P = P_0 - \rho g y \ ,$$

   where P_0 is the zero-point pressure at $y = 0$, ρ is the fluid density, g is the gravitational field magnitude near the Earth's surface (with fiducial value $9.8\,\mathrm{N/kg}$, and y is height with upward positive. Now air is not an incompressible fluid, but if we so approximate it, we can find a value for the altitude of the top of the atmosphere. Find this value. Note air pressure and density at the Earth's surface are, respectively, about 10^5 Pa and $1.2\,kg/m^3$.

   a) 10 m. b) 1 km. c) 10 km. d) 10000 km. e) 100 km.

10. "Let's play *Jeopardy*! For \$100, the answer is: This 17th century scientist who invented the barometer in 1643.

    What is ____________, Alex?

    a) Otto von Guericke (1602–1686) b) Evangelista Torricelli (1608–1647)
    c) Blaise Pascal (1623–1662) d) Robert Boyle (1627–1691) e) Robert Hooke (1635–1703)

11. "Let's play *Jeopardy*! For \$100, the answer is: It is a device for measuring gas pressure."

    What is a/an ____________, Alex?

    a) diving rod b) thermometer c) altimeter d) voltmeter e) barometer

12. "Let's play *Jeopardy*! For \$100, the answer is: This causes water to rise in a sucked on straw."

    What is ____________, Alex?

    a) higher-than-room-air-pressure pressure inside the straw b) lower-than-room-air-pressure pressure inside the straw c) the electric force d) the magnetic force e) the speed of light

13. "Let's play *Jeopardy*! For \$100, the answer is: The shape feature of containers for low and high pressure fluids. This feature allows container to rely more compressive and tensile strength of its material than on its shear strength than otherwise. Compressive and tensile strengths for many materials are greater than shear strength."

    What is ____________, Alex?

    a) cubicalness b) roundedness c) squarishness d) sofaness e) priggishness

14. "Let's play *Jeopardy*! For \$100, the answer is: This 17th century scientist who invented the vacuum pump in 1654.

    What is ____________, Alex?

    a) Otto von Guericke (1602–1686) b) Evangelista Torricelli (1608–1647)
    c) Blaise Pascal (1623–1662) d) Robert Boyle (1627–1691) e) Robert Hooke (1635–1703)

15. 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-spaceship 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. Bowman does **NOT** hold his breathe, and so air pressure in his internal cavities drops very quickly and rupturing does not occur. He has 10 to 15 seconds before losing consciousness.

16. "Let's play *Jeopardy*! For \$100, the answer is: This 17th century scientist who is credited with establishing Boyle's law in about 1662.

    What is ____________, Alex?

    a) Otto von Guericke (1602–1686) b) Evangelista Torricelli (1608–1647)
    c) Blaise Pascal (1623–1662) d) Robert Boyle (1627–1691) e) Robert Hooke (1635–1703)

17. "Let's play *Jeopardy*! For \$100, the answer is: For given amount of gas at constant temperature, pressure is inversely proportional to volume. As a formula:

$$p \propto \frac{1}{V} ,$$

    where p is pressure and V is volume. The law strictly holds only for an ideal gas, but it approximates the behavior of real gases to high accuracy and becomes exact in the limit of zero density."

    What is ____________, Alex?

    a) Hooke's law b) Boyle's law c) Towneley-Power law d) von Guericke's law
    e) Pascal's principle

18. If the volume of a gas sample is doubled isothermally, its pressure:

    a) halves. b) doubles. c) triples. d) bifurcates. e) stays the same.

19. The formula

$$PV = nRT$$

    (where P is pressure, V is volume, n is number of moles of gas, R is the ideal gas constant, and T is temperature on the Kelvin scale) is:

    a) Boyle's law. b) Charles's law. c) the ideal gas law.
    d) the zero-temperature degenerate gas equation of state. e) regrettable.

20. For an object to float in air, the following must hold:

    a) $\rho_{\text{object}} = \rho_{\text{air}}/2$. b) $\rho_{\text{object}} = 2\rho_{\text{air}}$. c) $\rho_{\text{object}} > \rho_{\text{air}}$. d) $\rho_{\text{object}} < \rho_{\text{air}}$.
    e) $\rho_{\text{object}} = \rho_{\text{air}}$.

21. The formula for incompressible, inviscid fluid

$$P + \rho g y + \frac{1}{2}\rho v^2 = \text{a constant along a streamline}$$

    (where P is the moving fluid's pressure, ρ is fluid density, g is the gravitation field magnitude near the Earth's surface, y is height, and v is fluid speed) is:

    a) Boyle's law. b) Hooke's law. c) Pascal's principle. d) Bernoulli's principle.
    e) Heisenberg's uncertainty principle.

22. Bernoulli's principle can be derived from the ____________ of classical mechanics. It can be thought of as the conservation of an energy quantity $P + \rho g y + \frac{1}{2}\rho v^2$ in the absence of viscosity.

    a) Newton's 2nd law b) Newton's 3rd law c) the work-energy theorem
    d) Newton's 1st law e) the conservation of momentum

23. The force that holds aircraft up in the air is aerodynamic lift which is actually a combination of the ____________ and the ____________.

    a) momentum lift; Pascal lift b) reaction lift; Pascal lift c) reaction lift; Bernoulli lift
    d) momuntum lift; Bernoulli lift e) reaction lift; Boyle lift

24. 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. This 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 the rise is caused by 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.