PHYS 1020 Final Exam

Monday, December 17, 6 - 9 pm

The whole course
30 multiple choice questions
Formula sheet provided

Seating (from exam listing on Aurora)

Brown Gym

A - SIM

Gold Gym

SIN - Z

Mastering Physics

Welcome to Physics 1020!

Instructors	Required Materials	Schedule	Policies/Evaluation	Suggested Problems	Formula Sheet
Answers to Even-Numbered Problems			Answers for tutorial test problems		
Answers for midterm test			Answers for final exam		
Marks files					

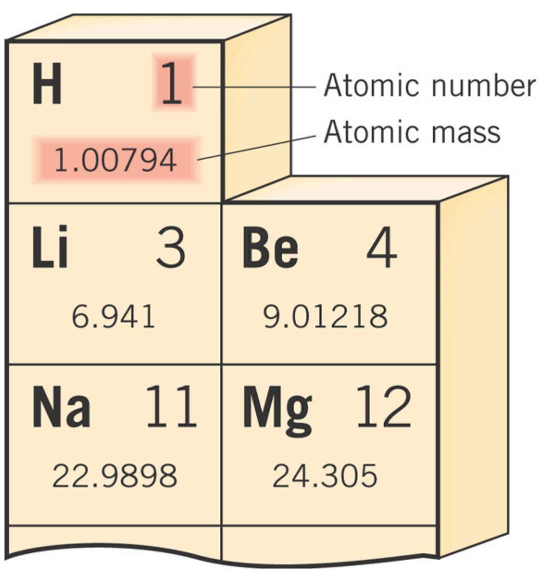
→ **Mastering Physics Assignment #5** ←
Due Monday, December 3 at 11 pm

Information on "Mastering Physics"

→ **Mastering Physics Survey** ←

Chapter 14: Ideal Gas Law and Kinetic Theory of Gases

- Molecular mass, the mole, Avogadro's number
- Ideal gas law
- Kinetic theory of gases



Molecular Mass

Periodic Table: shows

- atomic number
  - identifies chemical element
  - equal to number of protons in the nucleus of the atom
- atomic mass (atomic weight)
  - the mass of the atom in atomic mass units, u
  - the mass is the average over all of the naturally-occurring isotopes of the element

Atomic mass unit (u): the mass of the ^{12}C atom is exactly 12 u

The mass of naturally-occurring carbon is 12.011 u (^{12}C, ^{13}C, ^{14}C)

$1\ u = 1.6605 \times 10^{-27}$ kg

The Mole, Avogadro's Number

- Molecular mass: the sum of the atomic masses of all of the atoms in the molecule

- Gram-mole: the quantity of atoms or molecules with a mass in grams equal numerically to the atomic or molecular mass. The gram-mole contains Avogadro's number, N_A, of atoms or molecules,

$$N_A = 6.022 \times 10^{23} \text{ atoms or molecules per mole}$$

Atomic mass of Li = 6.941 u, so 1 gram-mole of Li has a mass of 6.941 g and contains N_A atoms

Molecular mass of H_2 = 2 × 1.00794 = 2.01588 u, so 1 gram-mole of H_2 has a mass of 2.01588 g and contains N_A molecules

14.5/1: A mass of 135 g of a certain element is known to contain $N = 30.1\times10^{23}$ atoms. What is the element?

The number of moles that are present is $n = N/N_A$ with a total mass of 135 g.

The mass of 1 mole must be:

$$\frac{135}{n} = 135 \times \frac{N_A}{N} = 135 \times \frac{6.022 \times 10^{23}}{30.1 \times 10^{23}} = 27.0 \text{ g}$$

From the table at back of book: atomic mass of Al = 26.9815

The element is aluminum

14.2/4: The active ingredient in Claritin has the chemical formula

$$C_{22}H_{23}ClN_2O_2$$

The standard adult dosage utilizes 1.572×10^{19} molecules. Determine the mass in grams of the active ingredient in the standard dosage.

Atomic masses (table in back of book):
C: 12.011 H: 1.00794 Cl: 35.453 N: 14.0067 O: 15.9994

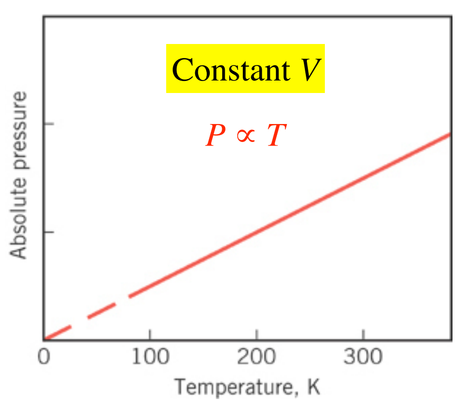
1 gram-mole has a mass of $22 \times M_C + 23 \times M_H + M_{Cl} + 2 \times M_N + 2 \times M_O$
= 382.9 g

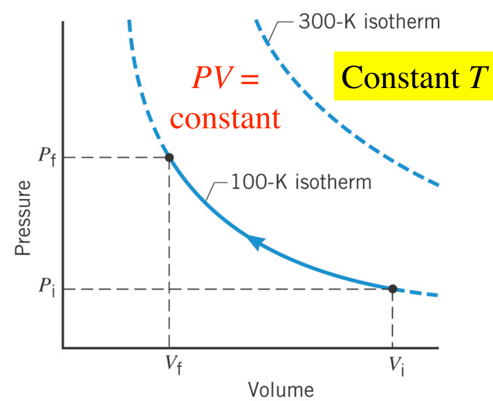
The dosage corresponds to:

$$\frac{1.572 \times 10^{19}}{N_A} = \frac{1.572 \times 10^{19}}{6.022 \times 10^{23}} = 2.61 \times 10^{-5} \text{ moles}$$

Therefore, the mass of the dosage is: $2.61 \times 10^{-5} \times 382.9 = 0.010 \text{ g}$

Ideal Gas Law





Ideal Gas: the atoms or molecules of the gas do not interact with each other, except through elastic collisions. Real gases approximate ideal if the pressure is not too high, so the density of the gas is low.

Then: $P \propto T$, if V, is held constant
PV = constant if temperature is constant (Boyle's law)

Ideal Gas Law

The behaviour of an ideal gas is described by the ideal gas law:

$$PV = nRT$$

n = number of moles of gas
R = universal gas constant = 8.314 J/(mol.K)
T in Kelvin

In terms of the number, N, of atoms or molecules of the gas:

$$PV = NkT$$

k = Boltzmann's constant = 1.38×10^{-23} J/K
$N = nN_A$, and nRT = NkT, so

$$k = \frac{R}{N_A}$$

Ideal Gas Law

For 1 mole of an ideal gas at standard temperature and pressure (STP)
[T = 273 K (0°C), P = 101.3 kPa]

the volume of the gas is, for n = 1 mole:

$$V = \frac{RT}{P} = \frac{8.31 \times 273}{1.013 \times 10^5} = 0.0224 \text{ m}^3 = 22.4 \text{ litres}$$

That is, 1 mole of gas at STP occupies 22.4 litres

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Mastering Physics Survey

Monday and Wednesday
Review - send questions!

Ideal Gas Law

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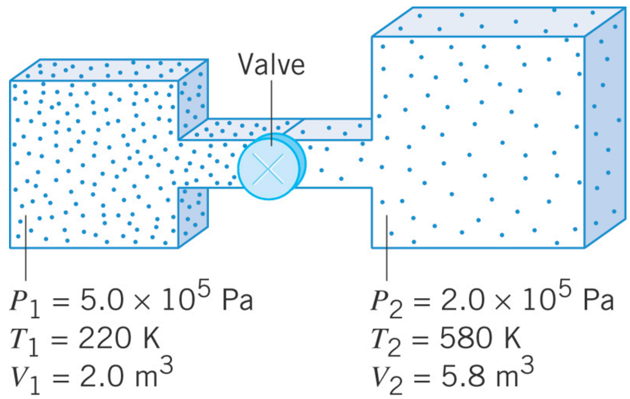
Q 15, 2005 Final: A sample of a monatomic gas is originally at 20°C. What is the final temperature of the gas if both the pressure and the volume are doubled?

14.10/46: It takes 0.16 g of helium to fill a balloon. How many grams of nitrogen would be required to fill the balloon to the same pressure, volume and temperature?

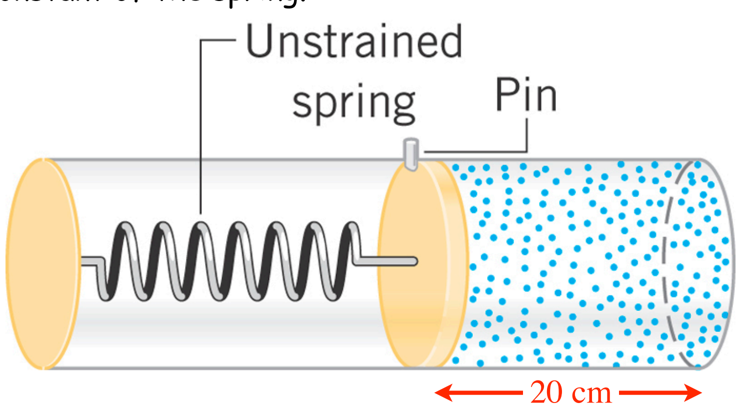
14.12/14: Oxygen for hospital patients is kept in tanks in which the oxygen has a pressure of 65 atmospheres at a temperature of 288 K. The oxygen is administered at a pressure of 1 atmosphere at 297 K. What volume does 1 m^3 of oxygen in the tanks occupy in the patient's room?

14.19/24: The tanks are connected by a valve, which is initially closed. Each tank contains neon gas at the pressure, volume and temperature indicated. When the valve is opened, the contents of the two tanks mix, and the pressure becomes constant throughout.

a) What is the final temperature? (the heat gained by the gas in one tank is equal to the heat lost by the other).
b) What is the final pressure?



14.26: A gas fills the right-hand portion of a horizontal cylinder whose radius is 5 cm. The initial pressure of the gas is 101 kPa. A frictionless movable piston separates the gas from the left portion of the cylinder, which is evacuated and contains a spring. The piston is initially held in place by a pin and the spring is unstrained. The length of the gas-filled region is 20 cm. When the pin is removed and gas is allowed to expand, the length of the gas-filled chamber doubles. The temperature of the gas does not change. Find the spring constant of the spring.



14.20/23: A diving bell consists of a cylindrical tank with one open end and one end closed. The tank is lowered into a lake with the open end downward. Water rises into the tank, compressing the trapped air, whose temperature remains constant. The tank is brought to a halt when the distance between the surface of the lake and the surface of the water in the tank is 40 m. Find the fraction of the tank's volume that is filled with air.

14.27: A cylindrical glass beaker of height 1.52 m rests on a table. The bottom half of the beaker is filled with a gas, the top half with liquid mercury exposed to the atmosphere. A frictionless piston separates the gas from the mercury.

The initial temperature is 273 K. The temperature is increased until half of the mercury has spilled out of the beaker. Find this temperature. Ignore thermal expansion of the glass and the mercury.